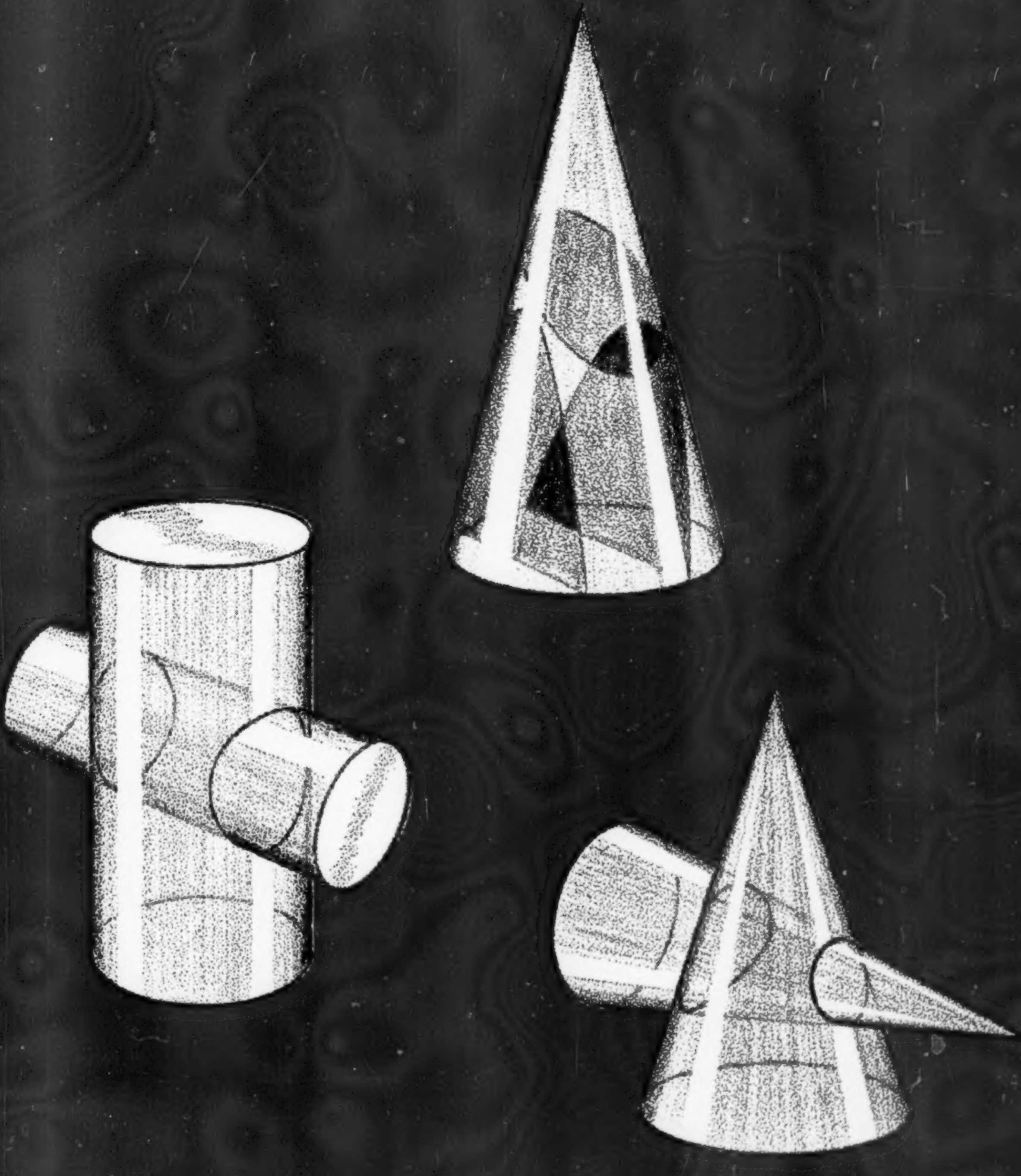
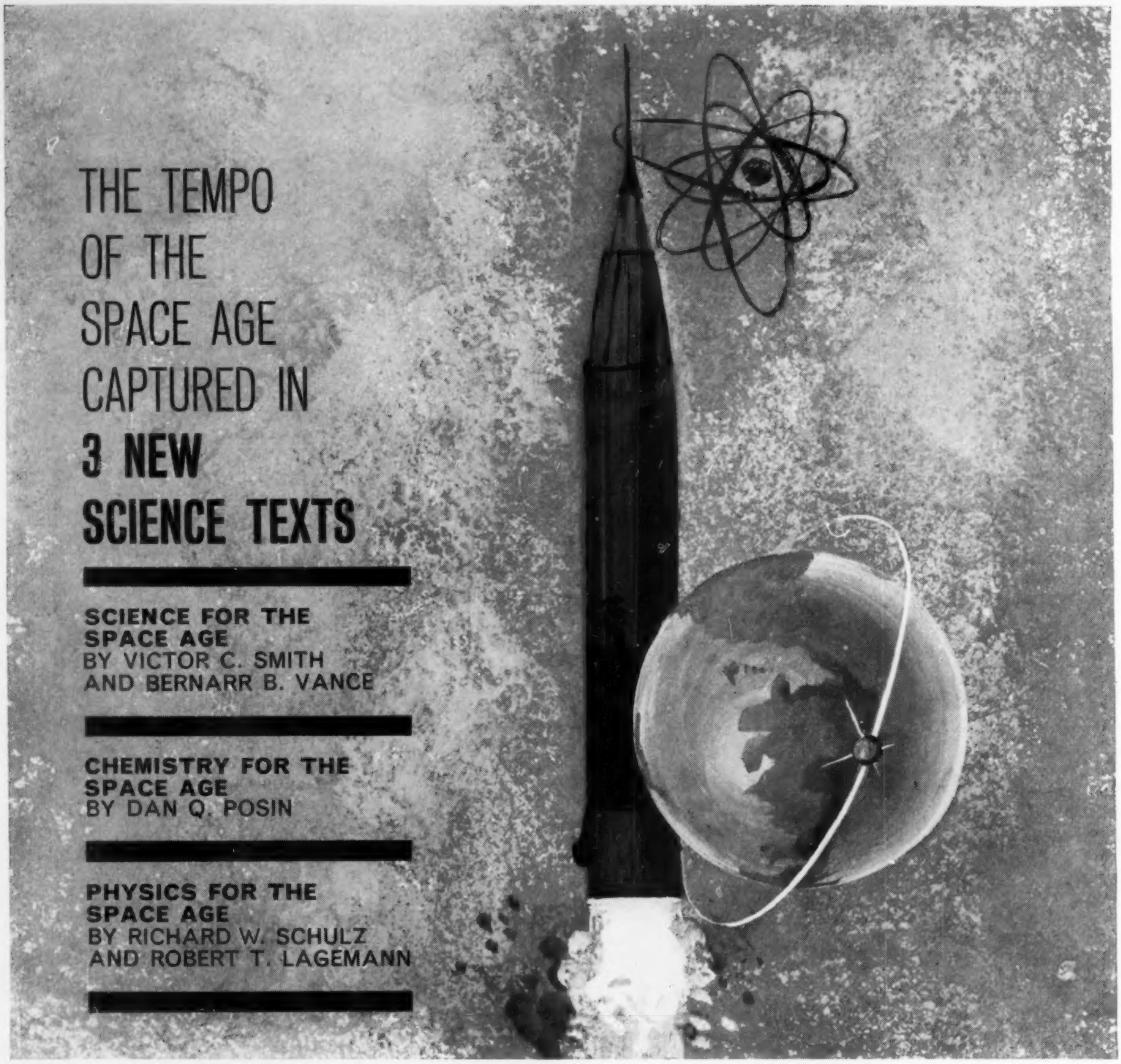
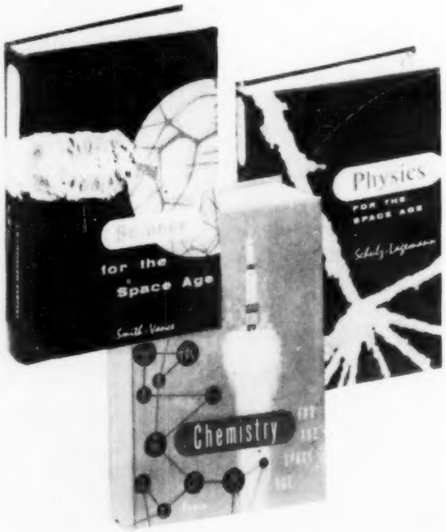
# THE SCIENCE TEACHER

VOLUME 28, NUMBER 1 • FEBRUARY 1961



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THE SCIENCE TEACHER



*The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.*

**Journal of the National Science Teachers Association**
**Volume 28, Number 1 • February 1961**

# Editorial

## The Arts in the Soviet Union

The arts are clearly an integral and important part in the life of the people of the Union of Soviet Socialist Republics. This is the unanimous opinion of the members of an official delegation, representing the Arts in Education, which recently returned from the Soviet Union. (Members of the delegation: Mayo Bryce, Specialist in Fine Arts, U. S. Office of Education; Ralph Beelke, Executive Secretary, National Art Education Association; and the writer, Vanett Lawler.) The delegation officially represented the U. S. Office of Education and was sent as a part of the Cultural Agreement between the Soviet Union and the United States.

It seems particularly appropriate to comment on certain aspects of the Arts in Education mission in the USSR in *The Science Teacher.* On more than one occasion in the Soviet Union, opportunities arose which enabled us to draw some interesting analogies as to the relative importance attached to education in the sciences and the arts in the Soviet Union.

Obviously the members of the delegation confined their visits to areas related to the fields of the arts—and particulary education in the arts. This included visits to Conservatories, Institutes of Music, Special Primary Schools (seven-year), Special Technicals (four-year), Music Schools, General Schools, Academies of Fine Arts, Special Primary and Technical Art Schools, Theater Schools, Ballet Schools, Circus Schools, Departments of Arts Education in Pioneer Clubs (for youth), and Houses of Culture for Workers (for adults and youth), the latter two being known as the amateur movement.

To be sure, education in the sciences is not being neglected in the Soviet Union. From everything we saw and heard, however, education in the arts is by no means an undernourished part of the educational program. The program of education in the Soviet Union seems to be moving forward on a united front, so to speak, dedicated to the ideals and ideology of that society.

In a conversation with the Minister of Culture, E. Furtseva, the only woman on the Central Committee in the Soviet Union, the question was directly asked as to whether in this particular era of technological development, there was a tendency to accelerate education in mathematics and science at the expense of education in the arts. The answer was direct and forthright. The Minister explained that all of education is regarded as serious business in the Soviet Union; that to be educated as a scientist, of course, requires the most intensive training and knowledge in a particular field of science, but a scientist's education does not end there. "Education in the arts, in the schools and in the amateur movements," said the Minister, "are regarded as important in the lives of our people."

Official patronage of the arts is not uncommon among many countries of the world. Somehow, in the Soviet Union, such official patronage is very obvious. Through the Ministry of Culture, there is enormous support for the education in the arts *and* for their presentation.

There is what might be called a national opinion and respect for the arts in the Soviet Union. A musician, painter, sculptor, dancer, actor can look forward to a career in Soviet society which will be as respected and as successful as that of the scientist, the lawyer, or the doctor. The artists seem to have no need for concern for a public. Concerts, ballets, theaters, the circus, galleries, and museums have large attendance. This is true not only in the case of professional offerings, but in the amateur presentations, in Pioneer Clubs for youth, in Houses of Culture for youth and adults. One evening 500 factory employees were observed going to a lecture in a House of Culture in Leningrad by a distinguished musicologist from the Rimsky-Korsakov Conservatory on "Romanticism in Music." In another House of Culture for Workers, engineers studied Puccini operas.

It must be borne in mind that the entire education program in the Soviet Union is geared to the political, economic, and cultural ideology of that country. It is an ideology which is contrary to the pattern of life and ideals of the United States. It was interesting to observe the deliberate use being made of the arts in the Soviet Union to advance the aims and ideals of that society. Members of the Arts in Education delegation had reaffirmed again their faith in the great power of the arts and returned to their country, proud to be sure of the fine programs in the arts in education here in the United States. At the same time, the experience in the Soviet Union shed new light on the conviction that education in the arts—perhaps some official patronage—can effectively be accelerated to advance and to insure the ideals we hold strongly and value.

VANETT LAWLER, *Executive Secretary*
Music Educators National Conference, NEA

THIS MONTH'S COVER . . . illustrates depth and perspective in design which leads to a new dimension in the study of biology, described in the lead article on page 6.

THE SCIENCE TEACHER

**Volume 28, No. 1 — February 1961**

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## General Rules

The manuscript should be informative, summarizing the basic facts and conclusions, and maintaining a coherence and unity of thought. Basically, be clear, be concise, be complete, and place yourself in the mind of the reader. The titles should be clear and accurate, but need not be lengthy. Rules for grammar and punctuation follow the usages summarized in the latest edition of *Webster's New Collegiate Dictionary*.

### 1. Preview

Manuscripts sent to the editorial office for review are accepted on a voluntary basis from authors. Before an article is submitted, please review the following suggestions. Original manuscripts received in correct form serve to expedite the processing and prompt reviewing for early publication. Spelling, punctuation, sentence structure, and the mechanical elements of arrangement, spacing, length, and consistency of usage in form and descriptions should be given careful study before submission.

### 2. Prepublication

No manuscript is accepted which has already been published or has been submitted to another journal for publication. Authors should include statement of nonpublication or submission with their letters of enclosure.

### 3. Acknowledgements

All manuscripts are acknowledged upon receipt without obligation for publication. Review of a manuscript may require from two to four months before a final decision is made for publication or rejection. When an article is selected for publication, the author is notified, and alterations may be made at that time. No galley proofs are sent to the authors before publication, and final editing is made by the publisher.

### 4. Manuscripts

a. Format—Submit original manuscripts in English, typewritten, double-spaced on one side of the paper, and in duplicate.

b. Length—In general, articles should not exceed 2000 to 2500 words. (Classroom ideas or feature articles run from 500 to 1000 words.)

c. Page size—Original should be on 8½- by 11-inch bond paper, with margins of 1½ inches on each side and at the bottom.

d. Title sheet—Include a title sheet to precede the first page of the article. Give the title of the article, name of author(s), present position or title, and name and location of school or college (city and state).

e. Pages—Number each page (except the title page) in Arabic numerals at the bottom of each page.

f. Bibliographies or references should be carefully selected and kept to a reasonable number of citations.

### 5. Footnotes

Number footnotes to *text* in single sequence with superior *figures* in order of appearance, and list at bottom of each sheet on which reference appears. (See examples.) For footnotes to *tables*, use superior *letters* (a, b, c, etc.).

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[1] John A. Smith. "The First Law of Motion." *The Science Teacher*, 26:33-6. February 1960.

[2] Sam A. Jones. *Hydrodynamics*. Oxford Book Company, Chicago, Illinois. 1960. p. 573-6.

[3] Samuel Schenberg. *Laboratory Experiments with Radioisotopes*. United States Atomic Energy Commission, Washington 25, D. C. August 1953.

### 6. Tables

All tables or tabular material should be prepared on a separate sheet at the end of the running text. Number in Roman numerals, and type captions at the top of each table. Avoid complicated column headings.

### 7. Figures

Line drawings should be planned for reduction to the $2\frac{5}{16}$-inch column width (14 picas). Lettering and symbols should be large enough so that they will be at least $\frac{1}{16}$-inch high after reduction. Lines should be broad and black. Use India ink and white paper for original drawings. Label all drawings with the word "Figure" and use Arabic numerals in consecutive sequence. Include captions on separate sheets, and also write figure and caption on back of each drawing.

### 8. Photographs

Submit photographs, if possible—glossy prints preferred, 8½ x 11 inches. Mark only with *grease pencil* on reverse to identify; captions should be typed on separate sheets.

### 9. Mathematics

Type or carefully print all such material. Separate lines should be used for each equation. If reference is needed in text, refer to as: Equation 1, etc. Use the solidus (/) for simple fractions to save vertical space.

### 10. Reprints

Reprints of articles are available after publication date. Orders for less than one hundred reprints are not accepted. Cost sheets and order forms will be sent to the authors, as well as three copies of the publication. Original photographs or line drawings may be returned to the author upon request. Artwork or cuts used in the publication are available at no cost to the author.

### 11. Check list for authors

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*Editorial Director*

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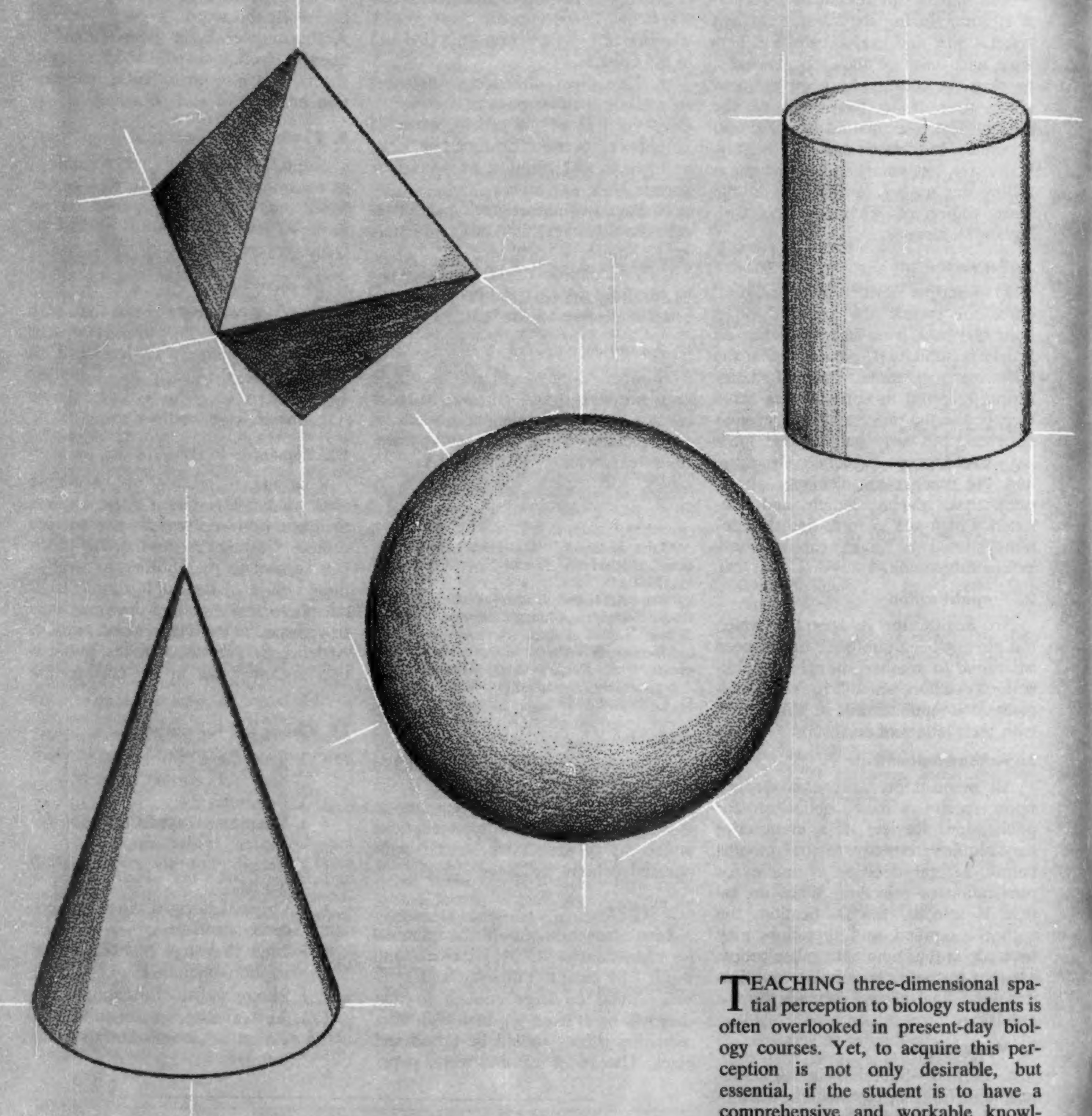
# Teaching Three Dim




By JEFFREY J. W. BAKER

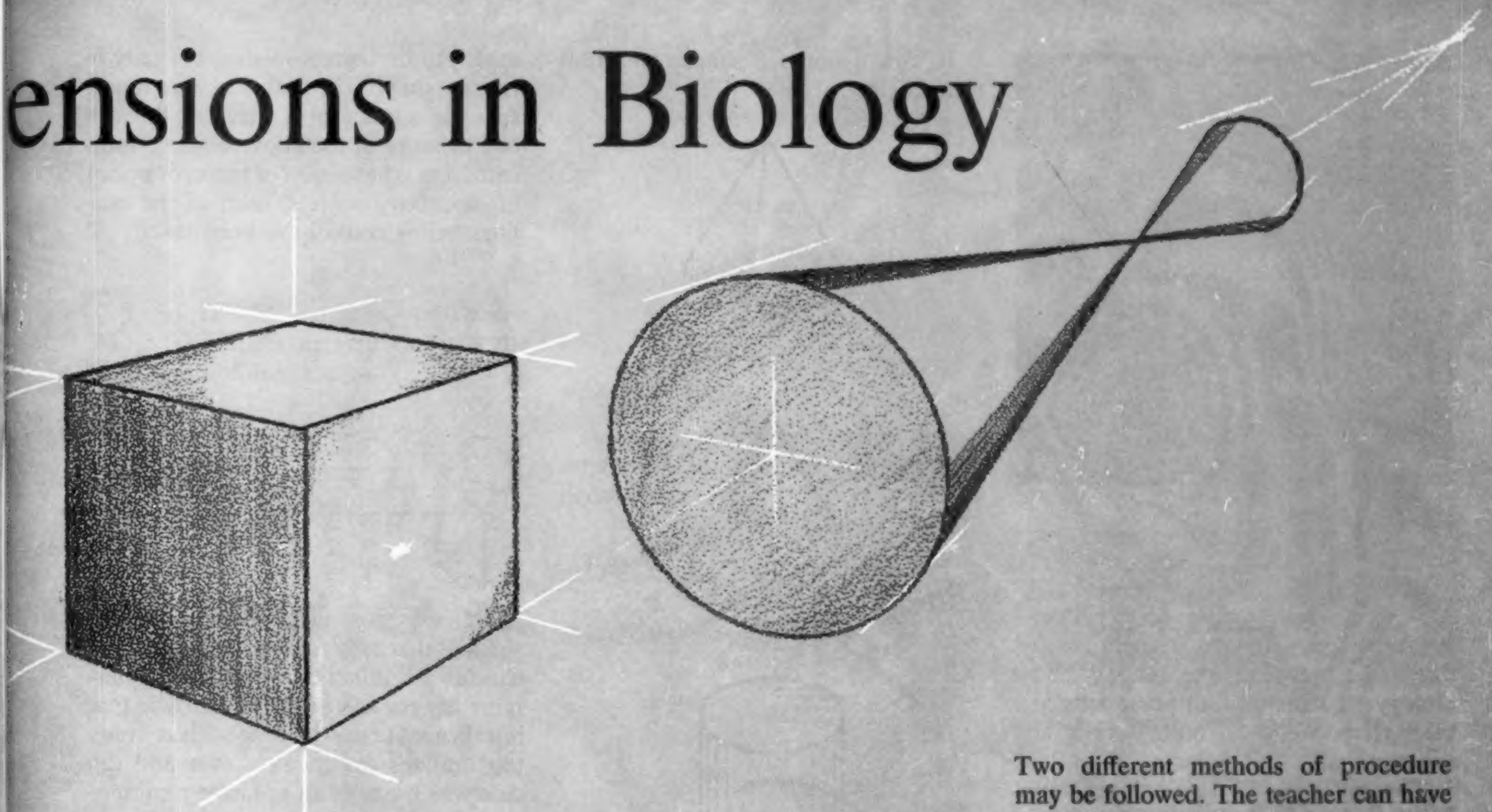
Biology Teacher, Mount Hermon School, Mount Hermon, Massachusetts

and ADDISON E. LEE

Director, Science Education Center, The University of Texas, Austin, Texas


TEACHING three-dimensional spatial perception to biology students is often overlooked in present-day biology courses. Yet, to acquire this perception is not only desirable, but essential, if the student is to have a comprehensive and workable knowledge of biology. We need to concentrate more and more on instilling in our students a basic *understanding* of our subject, rather than simply giving them facts to be recognized.

nensions in Biology



Many times teachers assume their students can see objects in the third dimension without making any attempt to develop or evaluate their aptitude for this perception. The knack of picturing a three-dimensional object from the study of two-dimensional sections is naturally present in some individuals and yet completely absent in others. Furthermore, the presence or absence of the ability is by no means related to other skills of the person. The brightest student may well be completely lost when tested for this type of perception. Conversely, the slower student may do quite well. Sectional drawings are very much a part of our present-day biology courses. Textbooks are filled with cross sections of roots, leaves, stems, worms, embryos; and longitudinal sections of flowers, root tips, and sponges. Much of our teaching may be wasted, if the student cannot apply what he has learned from a sectional view of an organism to the organism as a morphological whole.

Our purpose in this paper is not only to emphasize the importance of teaching three-dimensional spatial perception in biology, but to suggest some techniques for developing it. The authors have found the techniques helpful in their own teaching.

The following techniques are recommended for use early in the course for best effect, preferably before the students do any work with microscope slides.

1. The teacher can introduce the students to sections of geometric figures with which they are already familiar, such as cones, cubes, cylinders, etc. After drawing these on the blackboard or using models, the teacher can prescribe a "cut" through the figure. Each student is then instructed to draw how he thinks the cut surfaces will appear when the parts are separated.

2. Modeling clay may also be used advantageously. This substance is very pliable, and almost any figure the teacher desires can be easily made. The use of different colors is recommended. Two different methods of procedure may be followed. The teacher can have the students make the model that he designates, and then have them mentally make a "cut" through the model and draw on paper how they think the cut surfaces will appear. The teacher can also prepare the models in advance and pass them around. After the students have made their drawings, the "cuts" can actually be made with a razor blade, and the cut surfaces examined.

3. Prior to microscopic work in the course, the teacher should give the students a description and a demonstration, if possible, of the differences between a compound microscope and a stereoscopic microscope. This should then be followed by a brief description of the procedure for making permanent microscope slides. If a microtome is available, it could be demonstrated also.

4. The teacher can have the students look at slides with serial cross sections of various whole organisms. Then, it can be determined whether or not the student is making the proper interpretations by asking pertinent questions and by having him draw how he thinks the organism would appear as a whole.

5. By comparing material showing cross or longitudinal sections of cells

**NOTE: The artwork submitted with this article is by James Holmes, Associate Professor of Drawing, The University of Texas, Austin.**

PHOTO BY CHARLES HEIMSCH

**Section of pork-muscle tissue.**

with whole cells prepared by maceration techniques, the teacher can greatly dispel the prevalent idea among many biology students that all plant cells are brick-shaped and all animal cells are spherical.

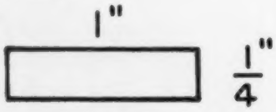
The following is a sample exercise which may be used to evaluate the ability of students to understand three-dimensional relationships.

### Procedures

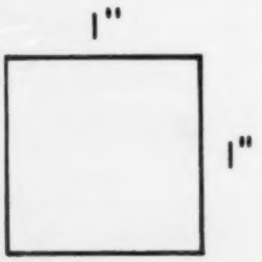
Read the directions very carefully for each section of the exercise.

(See Answers at end of article.)

I. Suppose a box had a cross-section view like this:

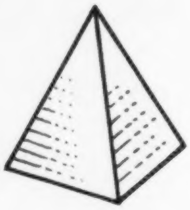



And a long-section view like this:

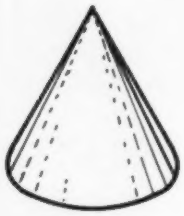



Make a three-dimensional drawing of such a box in the space below.

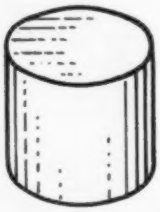
II. Six geometric shapes are illustrated below.



A. Pyramid

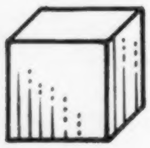


B. Cone

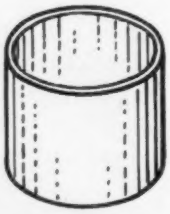


C. Solid cylinder

D. Sphere

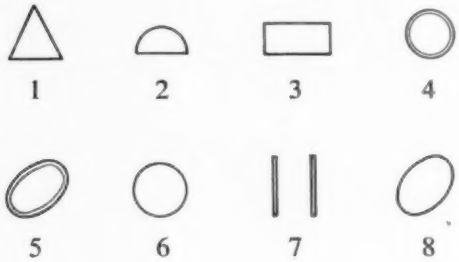


E. Cube



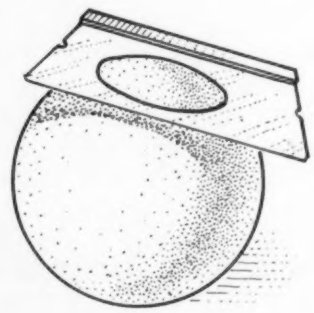
F. Hollow cylinder

Assume that a slice, cut with parallel lines in any *one* plane, were cut from any one plane through the object. Remember that these outlines represent the cut surface after the pieces would have been pulled apart. They are not meant to be correct in size, but only in relative shape. The outlines below represent the surface of a slice cut through one or more of the above objects. Indicate from which one (or more, or none) of the above objects, each of the outlines below could have been taken.




III. Observe clay models of the shapes that are drawn below. After careful examination, mentally determine the outline of the cut surface that is indicated in the drawings. Then, study the outlines drawn as shown and decide which one is an accurate representation of how the cut surfaces will appear, face on view, when the two parts are separated.

1. Select from these outlines represented by the cut which is illustrated. Mentally, make several other sections through the sphere below and some other spheres of different sizes. Make a general statement about the shape of any section through a sphere.



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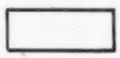
c 

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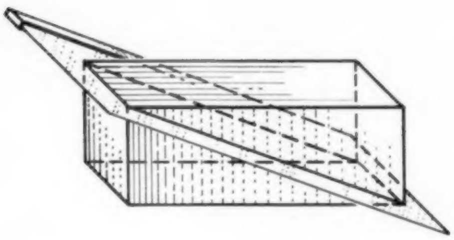
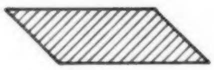
e 

2. Select the outline just below which represents the cut through the right prism illustrated.



a 

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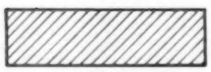
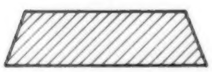
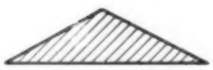
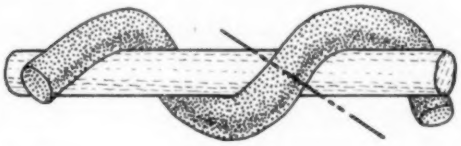
c 

d 

e 

3. Select the correct letter from outlines at bottom which represents the figure illustrated.



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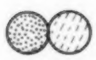
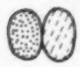
b 

c 

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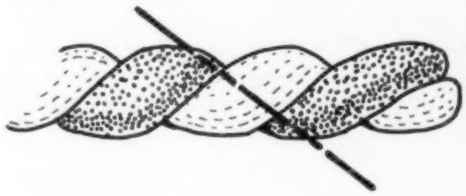
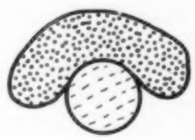
4. Select the correct letter of the outlines at bottom which represents the figure illustrated.



a 

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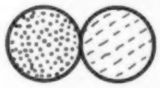
c 

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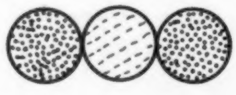
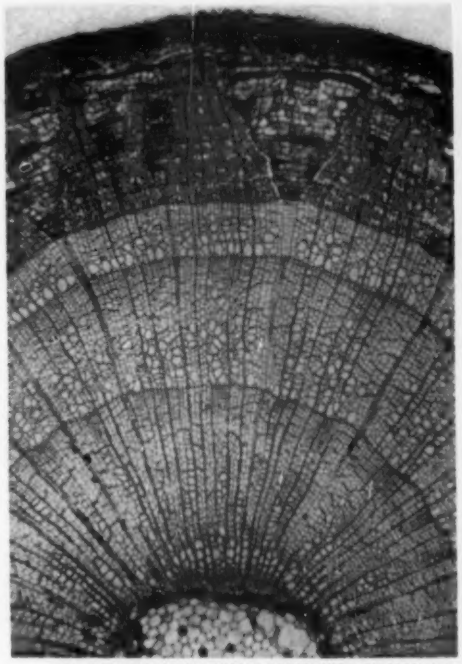
e 

IV. Often in biology you will be given slides containing cross sections or longitudinal sections of plants and animals to be viewed under the microscope. Since such sections are only a small part of the entire organism, it is essential that you recognize the relationship between the section you are viewing and the entire form. It is also important that you be able to reconstruct mentally the entire organism from a few sections. The following exercises are designed to give you practice in developing this ability. (See next page.)

1. Reconstruct the figure from which such sections might have been cut. Sections lettered the same have been cut in the same plane and are in proper position in relation to each other. Many sections are missing, however, between a and b, and b and c, etc.

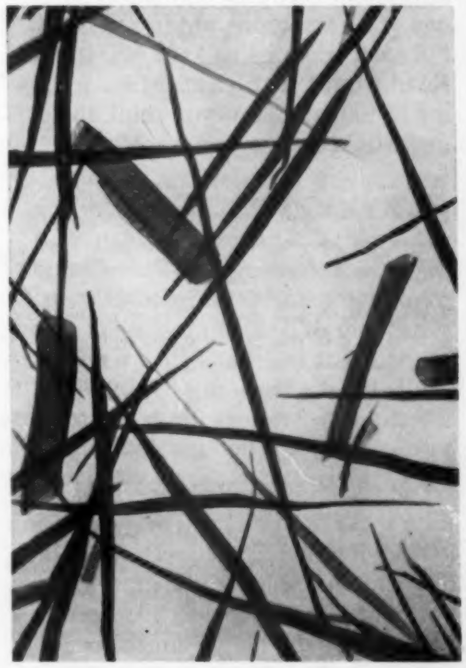


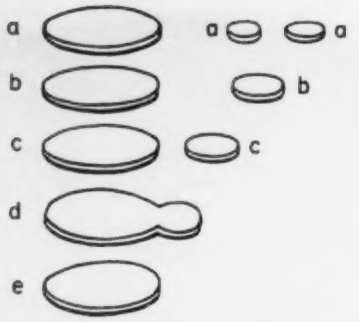
GENERAL BIOLOGICAL SUPPLY HOUSE, INC., CHICAGO, ILL.

**Cross section of basswood stem.**

**Macerated wood of basswood.**

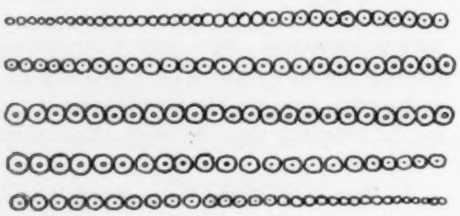
GENERAL BIOLOGICAL SUPPLY HOUSE, INC., CHICAGO, ILL.



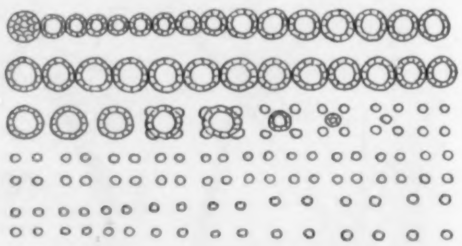



2. A certain plant cell was put into a paraffin block and section at 90° to its long axis with a microtome into the drawn sections (cross sections). These are serial sections, each cut ten microns thick. All sections are present. Read from left to right. Make a drawing in the space below to illustrate how this cell would appear as a whole. What would be its actual length in mm?

a. (                                    )



b. Below are some cross sections of an animal that you may study in biology. These sections are in serial order, but some are missing as in No. 1 above. Read from left to right. Make a drawing to illustrate how you think this animal would appear as a whole.



The accompanying photographs illustrate some examples you may encounter in studying microscopic sections in biology and will serve to illustrate the importance of being able to interpret what you see in the third dimension. The photo of pork-muscle tissue was made of a section containing the roundworm, *Trichina*. The section was cut with a microtome, and the slide prepared according to standard procedures. Suppose you saw only the ovals in the upper left and right of the illustrations. You would surely not gain much understanding of shape or size of the worms, and you would wonder how many worms are present in each oval (cyst). The lower cyst shows a near-median section and provides more information about the organism. (See page 8.)

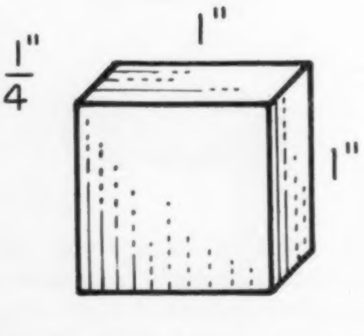
Two other photographs show items of the same material (basswood stem) and serve to illustrate different views and treatments of these same materials. Study of both, as well as others is important if the student is to understand the structure and organization of the basswood stem. (See page 9.)

You can prepare individual elements or cells from woody material by the following technique.

1. Cut woody material into very small pieces.
2. Place it in a test tube and cover with nitric acid.
3. Add a few crystals of potassium chlorate and heat gently until bubbles evolve. Allow to react until the material is white (4 to 5 minutes).
4. Pour into a dish of water and wash thoroughly.
5. Remove a bit of material to a drop of water on a clean slide and tease apart with dissecting needles. Cover with a coverslip and observe. If desired, such materials may be stained and mounted on the slide.

**Answers to Exercises**

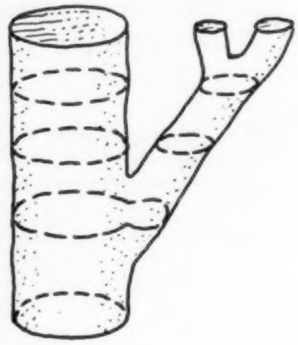
I.




II. 1. A, B, and E
2. B
3. C and E
4. F
5. F
6. B, C, and D
7. F
8. B and C

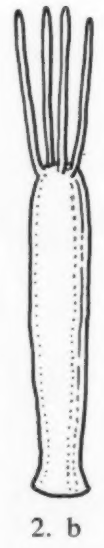
III. 1. a. (Any section through a sphere will be a circle.)
2. c
3. a
4. a

IV.

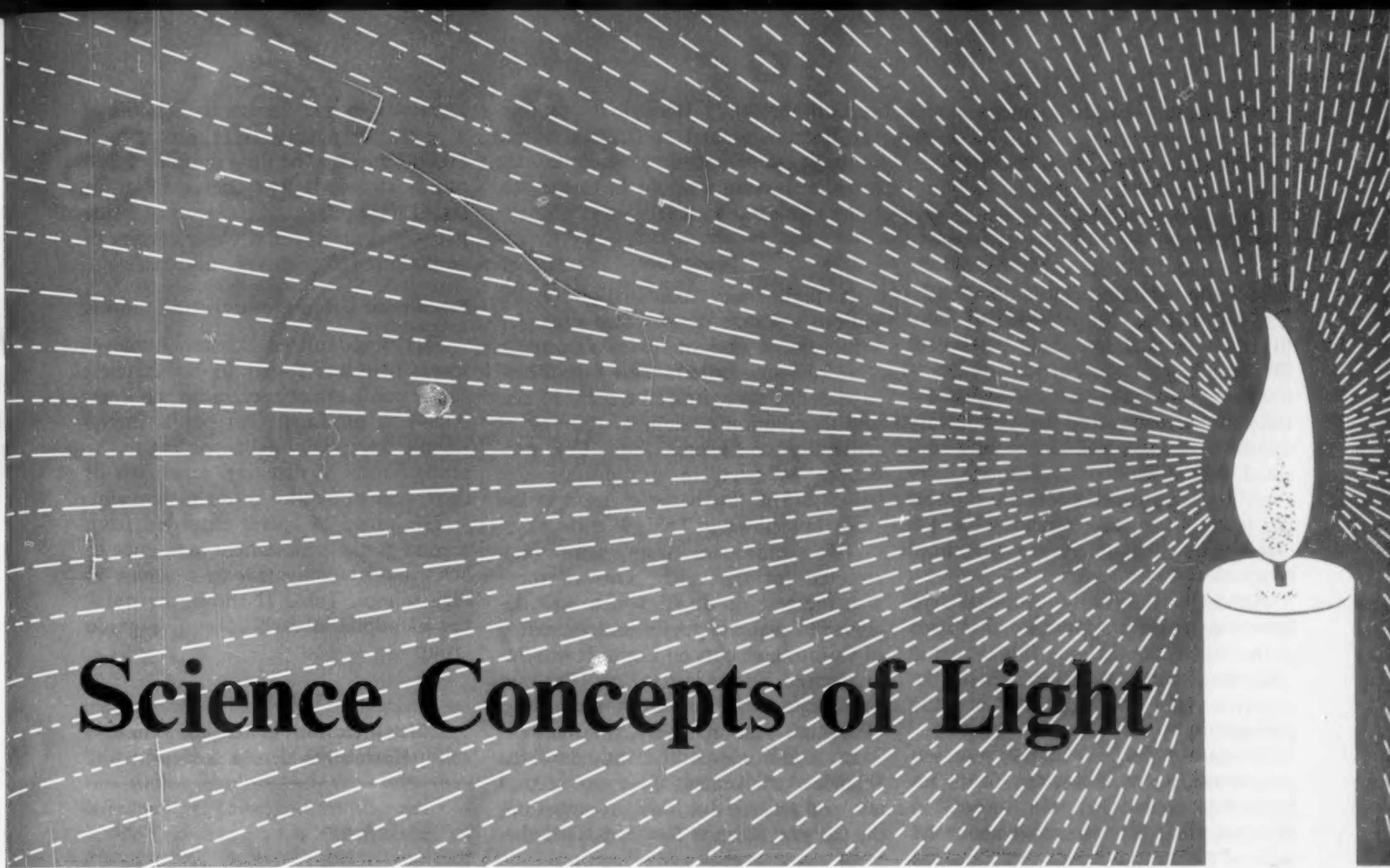


1

2. a



2. b



# Science Concepts of Light

## Use of Standardized Science Achievement Tests for Grade Placement

By GARY R. SMITH

Assistant Professor of Education, Wayne State University, Detroit, Michigan

and EDWARD VICTOR

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DURING the past three decades, the status of the science program for elementary school pupils has assumed an increasing importance for those persons who plan and teach science in the schools of the United States. Questions regarding the grade placement of science concepts, pupils' interests in various areas of science, and the previous training of persons who teach science are among the topics which have been discussed and studied.

The most recent evidence of the importance of science in the elementary school was reflected in the theme chosen for the National Science Teachers Association convention in Kansas City, Missouri.[1] The Association devoted its annual program to an examination of the problems and issues involved in developing a science program which would maintain a desirable continuity of topics from kindergarten through grade twelve.

To develop such a program in the elementary school, it would be necessary to apportion the responsibility for teaching the topics from the physical and biological sciences among the various grades, *i.e.*, deciding which concepts, generalizations, or principles would be suitable at each level.

At first glance one might consider this to be a relatively easy task. The most direct approach would be to start with the logical order implicit in each of the major disciplines — physics, chemistry, biology, geology, and astronomy. Present the simplest principles in each discipline to kindergarten children, the next most difficult ones to first-grade pupils, and continue this process throughout the successive grades.

Although little factual information is available on which generalizations are the most difficult for elementary school pupils, the major obstacle to this direct approach is found in the wide variety of pupil abilities in a single grade of the elementary school. For example, a chronological age group will exhibit considerable diversity in their achievement or aptitude to comprehend the proposed science concepts. The situation is further complicated because it is common for one grade to contain pupils with a chronological age range of three years or more. The fact that

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[1] Eighth Annual Convention, National Science Teachers Association, Kansas City, Missouri, March-29-April 2, 1960.

an elementary grade includes pupils from varying socio-economic backgrounds also compounds the problem of assigning science concepts.

During the past three decades, several attempts were made to improve this situation. Science specialists, school administrators, classroom teachers, and children were polled to identify their convictions about science in the elementary school curriculum. Questionnaires, quizzes, and interest inventories were completed by elementary school personnel, and the results analyzed. No method or technique, however, has been found adequate to meet the task of assigning science concepts throughout the elementary school program.

Although the early studies were largely descriptive appraisals of science in the elementary school, this report is concerned with an extension of the experimental investigations of the problem.

It was the purpose of this research project to determine if a significant relationship existed between success in understanding generalizations about the topic of **Light** and certain standardized tests of academic achievement and mental ability. Assuming that such a relationship did exist, the next step was to determine if the relationship were sufficiently pronounced to enable one to make reasonably precise predictions of pupils' abilities to understand generalizations about Light. If accurate, the age or grade norms obtained could be used to make recommendations for the *normative grade placement* of the science concepts in this study. Because the predicting instrument had been standardized upon a large, national sample, the recommendations would have the stability of such a sample.

### Procedure

A preliminary examination of the various standardized measures of achievement and aptitude was made. The following criteria were considered in selecting standardized tests: (1) size and distribution of sample, (2) size of reliability coefficients, and (3) procedure followed in establishing test validity. The test batteries used in the study are shown in Table I.

Two additional tests were constructed for the study. One of these was the test on Light which was designed to evaluate pupils' understanding of various concepts on Light. It was administered before instruction (Pre-unit Test on Light) and after instruction (Post-unit Test on Light).

In addition to the Standardized Science Achievement Test, the second test constructed for this investigation, the General Science Test, was used also to measure pupils' achievement.

Suitable concepts and generalizations about reflection and transmission of Light, refraction of Light, and color were selected. These generalizations were chosen from textbooks commonly used in elementary schools, junior high schools, and senior high schools and were organized into a teaching unit, with pertinent demonstrations and reading material.

Permission was obtained to conduct the study in the elementary schools of a midwestern city of approximately 80,000 pupils. The final sample of 260 pupils included: five classes of grade six (130 pupils); three classes of grade five (65 pupils); and three classes of grade four (65 pupils).

### Placement Using Standardized Norms

The Standardized Science Achievement Test was found to be the best single predictor of success on the Post-unit Test on Light. All pupils in the sample were classified according to the grade norms of that test, regardless of their regular school-grade assignment. The range of scores extended from second-grade achievement in science to achievement equivalent to a senior in high school. Table II shows the number of pupils in each normative grade group.

**TABLE II**

**Classification of Pupils into Normative Grade Groups**

| Grade Norm | Number of Pupils |
|---|---|
| Fourth grade or lower | 26 |
| Fifth grade | 46 |
| Sixth grade | 52 |
| Seventh grade | 57 |
| Eighth grade | 30 |
| Ninth grade or higher | 49 |
| Total | 260 |

Although the subjects in this study were intermediate-grade pupils, Table II indicates that many of them had scores on the Standardized Science Achievement Test which were comparable to the average achievement of students in junior high school and senior high school.

It is important to note that this study was concerned specifically with the identification of science concepts which could be understood by elementary school pupils. Therefore, a decision that a science concept could be understood by pupils in normative grades seven, eight, or nine should be interpreted to mean that elementary school pupils who have science-achievement scores equivalent to the average seventh-, eighth-, or ninth-grade student can probably understand the concept.

Each question on the Light Test had been written specifically to measure

**TABLE I**

**Standardized Tests**

| Standardized Test | Variable Measured |
|---|---|
| Stanford Achievement Test, Intermediate Battery, Form J and JM | Paragraph Meaning<br>Word Meaning<br>Arithmetic Reasoning<br>Arithmetic Computation |
| Stanford Achievement Test, Intermediate and Advanced Science Test, Form JM | Science Achievement |
| Kuhlmann-Anderson Intelligence Test, Forms E, F, G | Mental Age<br>Intelligence Quotient |
| Thurstone Primary Mental Abilities Test, Ages 7-11 | Verbal Ability<br>Spatial Relationships<br>Reasoning<br>Perception<br>Number<br>Total PMA Raw Score |

**TABLE III**

| Major Topic | Subtopic | Number of Questions on Light Test |
|---|---|---|
| A. Reflection and Transmission of Light | 1. Transmission of light | 4 |
| | 2. Reflection of light from smooth and rough surfaces | 4 |
| | 3. Reflection of light from plane mirrors | 5 |
| | 4. Reflection of light from concave mirrors | 5 |
| | 5. Reflection of light from convex mirrors | 3 |
| B. Refraction of Light | 1. Passage of light through different media | 4 |
| | 2. Refraction of light by convex lenses | 12 |
| | 3. Refraction of light by concave lenses | 3 |
| C. Color | 1. Spectrum | 6 |
| | 2. Primary colors of light | 7 |
| | 3. Primary pigment colors | 7 |
| | Total | 60 |

pupil understanding of a particular concept or generalization included in the unit of instruction. Table III identifies the major topics and the subtopics which were presented in the unit of instruction and shows the number of questions which were used to appraise pupil understanding of the concepts within the various subtopics.

An item analysis of each question on the Post-unit Test on Light was conducted. This analysis identified the proportion of pupils in each normative grade group who responded correctly to the particular question. Since each question was associated with a specific concept or generalization contained in the unit of instruction, it was possible to estimate the difficulty of the various topics by considering the average difficulty of the respective questions which checked pupil understanding of those topics.

The relationship between percentages of pupils passing a particular test item and the normative grade groups was plotted for each question on the Post-unit Test on Light.

Although variations appeared in the graphs for the individual test items, three basic patterns emerged. (See Figure 1.)

Pattern No. 1 was typical of questions which asked for the meaning of a word or questions requiring the pupil to identify the shape of a particular object, *e.g.*, a lens, a mirror.

Pattern No. 2 was typical of questions in which the pupil was asked to apply an understanding to a particular situation, *e.g.*, identify a concave lens and then identify the path of a beam of light through the lens. Pattern No. 2 was often modified to show a linear relationship between the difficulty of the question and the various normative grades.

Pattern No. 3 was typical of questions in which the pupil was required to know the meaning of at least two objects or definitions and to apply this understanding in a complex relationship, *e.g.*, know the meaning of concave mirror, object, and image and know

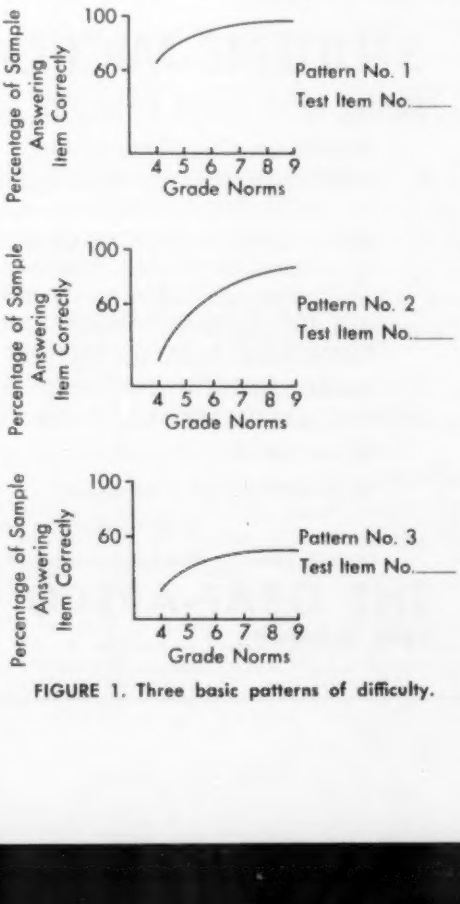



FIGURE 1. Three basic patterns of difficulty.

that an object close to a concave mirror results in a large image.

Test items which had Pattern Nos. 1 and 3 indicated a meager relationship between the percentage of persons responding correctly to the question and the normative grade group. The important factor, however, was the level (percentage correct) at which a pattern occurred.

Following the precedent set by Starrett,[2] it was decided that a concept or topic would be considered suitable for a normative grade group when more than 60 per cent of that group responded correctly to questions associated with that concept or topic.

Concepts which had questions following Pattern No. 1 were understood by pupils whose science achievement scores ranged from fourth through ninth grade, *i.e.*, at least 60 per cent of each normative grade understood the concept after a unit of instruction.

Concepts which had questions following Pattern No. 3 were too difficult for these elementary school pupils, regardless of their science achievement background, *i.e.*, less than 60 per cent of each normative grade understood the concept following the unit of instruction.

Test questions characterized by Pattern No. 2 and its linear variations had to be examined carefully to determine whether or not the associated concept was suitable for a particular normative grade group. In this pattern, the proportion of pupils who were able to understand the related science concept varied directly with the normative grade group.

A careful examination of these graphs was undertaken to make recommendations for the grade placement of each topic included in the unit of instruction on Light. The specific recommendations are reported in the author's current dissertation, and they will be published in a later article.[3]

### Implications

With judicious use, this method of scaling the difficulty of science concepts for elementary school pupils can be a

[2] George Starrett. "Determining Grade Placement of Heat Principles in Junior High School." Unpublished Doctor's Dissertation. University of California, Los Angeles, Californa. 1957.

[3] Gary R. Smith. "An Examination of Selected Measures of Achievement and Aptitude for Use in Normative Grade Placement of Science Concepts on Light." Unpublished Doctor's Dissertation. Northwestern University, Evanston, Illinois. 1960.

valuable technique in organizing the curriculum. This approach can serve as a preliminary step toward solving the grade-placement dilemma.

Certainly, there is nothing sacred about grade norms. They simply provide estimates of the average achievement of a group of pupils. They have all of the limitations implied in the words "average" or "norm." They can serve, however, as units of measurement to permit an initial classification of the difficulty of science concepts or generalizations.

There is no reason why the grade norms of one test publisher should be preferred to those of any other publisher. The important consideration in choosing the standardized test is that extremely careful procedures have been followed in selecting the normative sample and in establishing the validity and reliability of the test instruments.

If this procedure for grade placement were followed, each science topic would be assigned a difficulty index for each normative grade group. Each difficulty index would provide an estimate of the percentage of pupils in the normative grade group who could understand the particular concept, generalization, or topic.

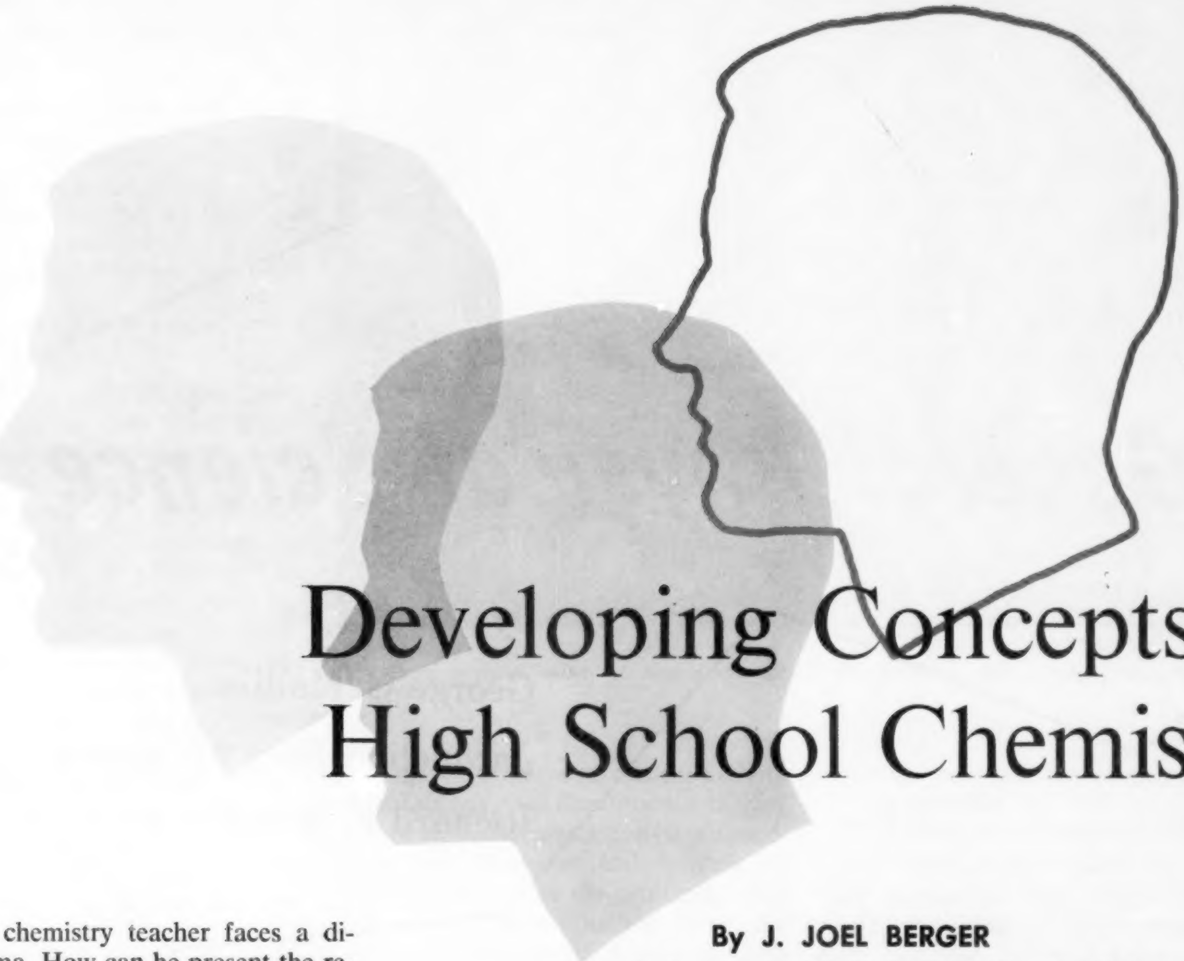
The use of these difficulty indices and the normative grade classifications would help to identify those science concepts which elementary school pupils could learn with reasonable effort. It would help to identify those science concepts which have no place in an elementary school program, but should be deferred to junior or senior high school.

If a school system wished to use these normative standards, its first obligation would be to assess the capacities of the pupils in that school system to understand science concepts. This would be done by examining their scores on the Standardized Science Achievement Test.

Next, the school authorities would have to decide whether the difficulty indices of the various topics, *e.g.,* principles or understandings from physics, chemistry, biology, geology, and astronomy were within the capacities of the pupils. With this information and an understanding of their local curriculum needs, it would be possible for the school authorities to organize a sound program in science for their pupils.

After the grade placement of a particular topic in science, the success of pupils in understanding the topic would be contingent upon a thorough understanding of the topic by teachers, and a carefully organized unit of instruction with suitable apparatus and reference material.

The use of normative grade groups to classify the difficulty of science concepts is merely an initial step in the careful organization of the elementary school science curriculum. Many elements of science education are omitted in a classification system such as this, *e.g.,* problem-solving skills and application of the scientific method. Further refinement of testing instruments and teaching techniques may make it possible to measure these qualities with some reliability. For the present, it is necessary to work with the tools which are available.



# Developing Concepts in High School Chemistry

By J. JOEL BERGER
Science Teacher, New Utrecht High School, Brooklyn, New York
and HOWARD B. BAUMEL
Science Teacher, New Utrecht High School, Brooklyn, New York

THE chemistry teacher faces a dilemma. How can he present the required subject matter in such a manner that concept development and not mere memorization takes place?

The classroom situation illustrates this problem. Chemistry high school students are called upon to deal with abstractions and theories which have little relation to their previous experience. Atomic structures, valence, the nature of the elementary particles, electronic configuration, bonding in compounds, and oxidation-reduction reactions are but a few of the concepts basic to the understanding of chemistry. Yet these fundamental principles are often the ones which are least mastered by the student.

A need for concentrated efforts in the area of concept development has been indicated by a number of authorities.[1] To follow this course, the teacher first must familiarize himself with the nature of concepts as well as methods which will promote their formation.

Perhaps the simplest working definition of a concept is offered by Brandwein[2] who considers it to be "the simplest pattern which helps us order the events around us . . . a reduction of events to a recognizable pattern."

It is assumed that the individual possesses an inherent desire to reduce the phenomena of life to their simplest elements. Bruner[3] refers to these processes as concept attainment and lists "strategies" which are designed to help the individual succeed in this task:

1. To insure that the concept will be attained after the minimum number of encounters with relevant instances.

2. To insure that a concept will be attained with certainty, regardless of the number of instances one must test en route to attainment.

3. To minimize the amount of strain on interference and memory capacity while at the same time insuring that the concept will be attained.

Significantly, these drives are found within the learner. Can the chemistry teacher instruct effectively to reinforce rather than interfere with these student aims?

Chemistry is such a broad field with so many different aspects that it tends to overwhelm the student. Frequently, the student has difficulty in comprehending each concept as an individual concept. As a desire to reduce this complexity exists, the teaching method must enable the student to accomplish a simplification of the events with the greatest efficiency.

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[1] *Rethinking Science Education.* Fifty-ninth Yearbook of the National Society for the Study of Education, Part I. The University of Chicago Press, Chicago, Illinois. 1960. p. 33-36.

[2] Paul F. Brandwein, Fletcher G. Watson, and Paul E. Blackwood. *Teaching High School Science.* Harcourt Brace and Company, Inc., New York. 1958. p. 110.

[3] J. S. Bruner, I. J. Goodnow, and G. A. Austin. *A Study of Thinking.* John Wiley and Sons, Inc., New York. 1956. p. 54.

If each item is classified or categorized, the following results will be achieved.

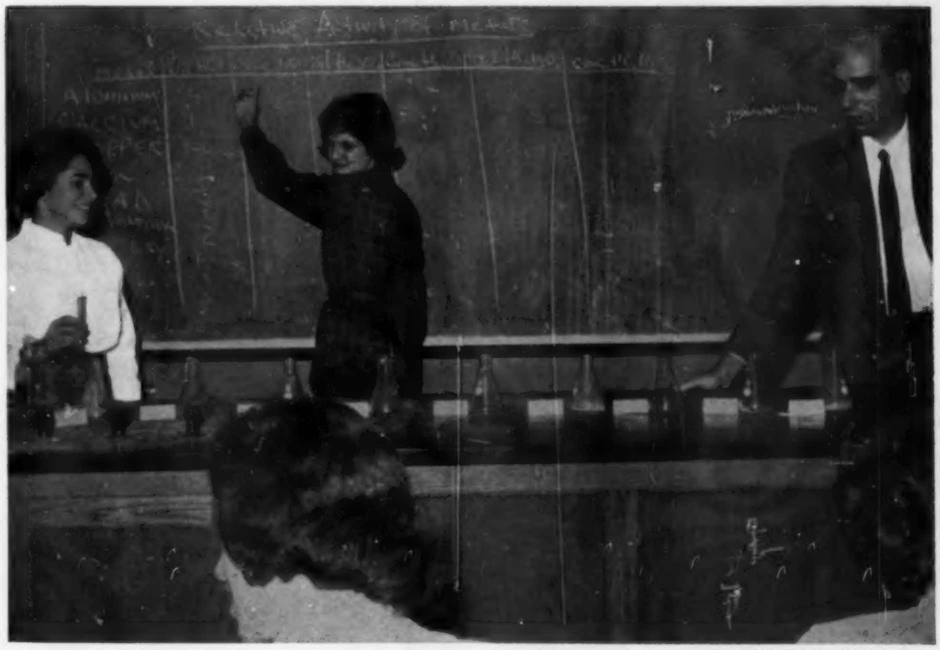
1. A reduction of the complexity of the subject matter.
2. Identification of the objects included in the subject.
3. A reduction of the necessity for constant learning.
4. Provision of a direction for future thought.
5. The ordering and relating of classes of events.

In light of these principles, the chemistry teacher should stress the relationships among atoms, compounds, and reactions. If each chemical property is shown to be a part of a greater body of chemical principles, then it can be understood more easily by the student.

Facts such as "Sodium liberates hydrogen from water, whereas zinc liberates hydrogen from certain acids, and copper does not liberate hydrogen from any compound" can easily be memorized by the student. Yet these facts will have little meaning if they are not related to each other and to the general activities of all metals.

A procedure which may aid concept development in this specific case involves a direct examination of the reactions of various metals with different acids of varying concentrations. Equivalent weights of at least seven different metals should be prepared. They can be placed in labeled flasks so that the class will be able to identify each metal. A standard amount of acid in contact with each acid will bring varying evidences of reaction and different quantities of hydrogen produced. A tabulation of the results should be made, with the metals rated in decreasing order of activity. These results may then be compared with the handbook values.

Occasionally some discrepancies arise between experimental data and accepted values. The class should be challenged to offer explanations of why such deviations occurred. In addition, certain predictions should be made on the basis of the reference material. These predictions should then be tested for validity. The prediction that potassium is more active than sodium, for example, may be substantiated by using each of them in a reaction with water. The similarity of these two metals can also be established at the same time.



JERRY WACHTEL, BROOKLYN, N. Y.

**Students assist teacher (J. Berger at right) in demonstrating relative activity of metals.**

Once the concept of relative activity of metals has been developed, a discussion of atomic structure can be initiated. Structural diagrams and models of atoms will illustrate the similarities and differences between metals. After the individual characteristics of each atom are examined, the effects of the structural differences should be discussed. Here, too, certain exceptions to the general principle are evident. A metal such as lithium is an apparent contradiction in terms of the effects of structure upon activity. By requiring the students to establish logical reasons for such exceptions, the teacher not only reinforces the concept, but also stimulates scientific thought.

The procedure described above is one that is dependent upon observation through demonstration to arrive at a conclusion. Yet, in certain aspects of chemistry, demonstrations are not possible. Abstract topics such as nuclear structure must rely upon models, diagrams, and films. Moreover, the student must deal with totally new ideas.

In terms of learning a new concept—one totally alien to previous experience—the following factors may influence the ease with which a concept is attained.

1. The definition of the task.
2. The nature of instances encountered.
3. The nature of validation.
4. The consequences of specific categorizations.
5. The nature of imposed restrictions.

The learner must have the proper "set" toward the task. Not only must he know precisely what is expected of him, but also he must approach the problem without any predilections. If the student has a preconceived idea or attempts solution through rote process, the attainment of the concept is increased in difficulty.

The second factor relates to instances which give a false picture of the total category. In attempting to discover the attributes of the category, the student bases his conclusions upon the evidence which is available.

Closely allied with the instances encountered is the nature of validation. If the tentative attributes of the category can easily be verified, then the concept will be developed with optimum efficiency.

Finally, the factor of imposed restrictions enters the picture. The nature of the experience itself, whether it is visual or entirely verbal, will affect the time in which the concept will be attained.

A somewhat different sequence is presented by Russell.[4] The first step involves the perception—a stimulation of the senses—of the event. The student

[4] David Russell. *Children's Thinking*. Ginn and Company, New York. 1956. p. 231.

recognizes the presence of the phenomenon in question, and then proceeds to an abstraction of this event. The process of abstraction involves the linking of one sensory experience to another during which some details become dominant. The final act in the process is one of generalization, by which the dominant detail resulting from abstraction forms a basis for responding in a like manner to the separate objects or events linked to the abstraction. Vinacke also endorses this view of concept development.[5]

Drawing from these theories of concept formation, the teacher might follow this pattern to develop concepts:

1. Determine the previous experience of the learner. Following Bruner's idea of categorizing as a strategy of concept attainment, the teacher should know if the student can associate the new situation with previously established categories.

2. Present the situation in such a manner that the student desires to reduce the event to a concept. The role of motivation and the teacher's personality are of vital importance. No concept formation will result if the student does not feel a need for it.

3. Allow the student to propose hypotheses and explanations. Each student should participate in the process of abstracting the observed phenomenon. Atkin[6] indicates that a permissive classroom atmosphere, as opposed to a rigid atmosphere, is most conducive to original student hypothesizing. The teacher should elicit as many different ideas as possible. Although this procedure takes a considerable amount of class time, in terms of the aims, it is time well-spent.

4. An interpretation of the observed event in light of the suggested hypotheses will result in eliminating those hypotheses which do not apply. By following this procedure the teacher provides for further student abstraction.

5. Finally, the class, guided by the teacher, will develop the proper explanation for one event. Generalization through class discussion will establish a particular category into which this event can be placed. The student then should be able to identify similar events as part of the general category, and the concept will become clearly fixed in his mind.

Contrast this proposed method with the widely practiced dictation of concepts to the students, and the consequent memorization and verbalization on an examination. The student repeats the words but does not truly understand them. Carpenter[7] points out that functional learning is more effective than rote memorization and that concepts are more thoroughly understood when the student has the opportunity to work with the objects involved.

That the method must be related to the objective cannot be overstressed. If it is desirable to develop concepts, then teachers must devote themselves to that end, for it is only through a concerted effort that these goals may be achieved.

[5] Edgar Vinacke. *The Psychology of Thinking.* McGraw-Hill Book Company, Inc., New York. 1952. p. 104.

[6] J. Myron Atkin. "An Analysis of the Development of Elementary School Children in Certain Aspects of Problem Solving Ability." Doctor's Thesis. New York University, New York. 1956.

[7] Finley Carpenter. "The Effect of Different Learning Methods on Concept Formation." *Science Education,* 40:282. October 1956.

# MOTIVATION FOR SCIENCE

**The two articles by authors Weisgerber and Gilkey are being reported as a follow-up to the summaries given from time to time on new film projects.**

**The findings and evaluations will be of considerable help to give the classroom teacher guidance in the areas reported.**

**By ROBERT A. WEISGERBER**

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IN recent years many editorials and magazine articles have been written about the "crisis" in science education. Similarly, much has been written about the teacher's role in counseling students to make wise educational and vocational choices. The problem of aiding students to make wise decisions regarding their elected courses first came to the attention of the investigator as a teacher of general science in the seventh, eighth, and ninth grades. It was apparent that many of the students who had excellent science potential were discontinuing their science studies after making the transition to high school. Conversations with many of these students led the investigator to surmise that misinformation, or more often lack of information, had given them an incorrect impression of what advanced study in the sciences and a career in the sciences would be like. It is apparent therefore that more adequate information must be provided.

Currently, there is a press for more research concerning new approaches to the old problem of guiding students. Elevazo,[1] in a Doctor's Thesis concerned with content analysis of guidance films, suggested that a need exists for more research on the contributions of films and other audio-visual materials to the guidance program. The study reported here[2] attempted to explore the possibility of using films as a method of giving students an insight into the field of science as it concerned their present and their future in science.

### Problem

The problem was to determine experimentally the effect of a battery of science motivational films on the attitudes of secondary students toward the field of science. Essentially, three questions were posed:

1. Does a student change his attitude toward science as a result of seeing science motivational films?
2. Does a student increase his interest in science activities as a result of seeing science motivational films?
3. Does a student exhibit a greater preference for selection of science courses, when alternatives are presented to him for the next school term, as a result of seeing science motivational films?

### Procedure

Three instruments were used to assess these effects. The first was a four-part attitude scale regarding student

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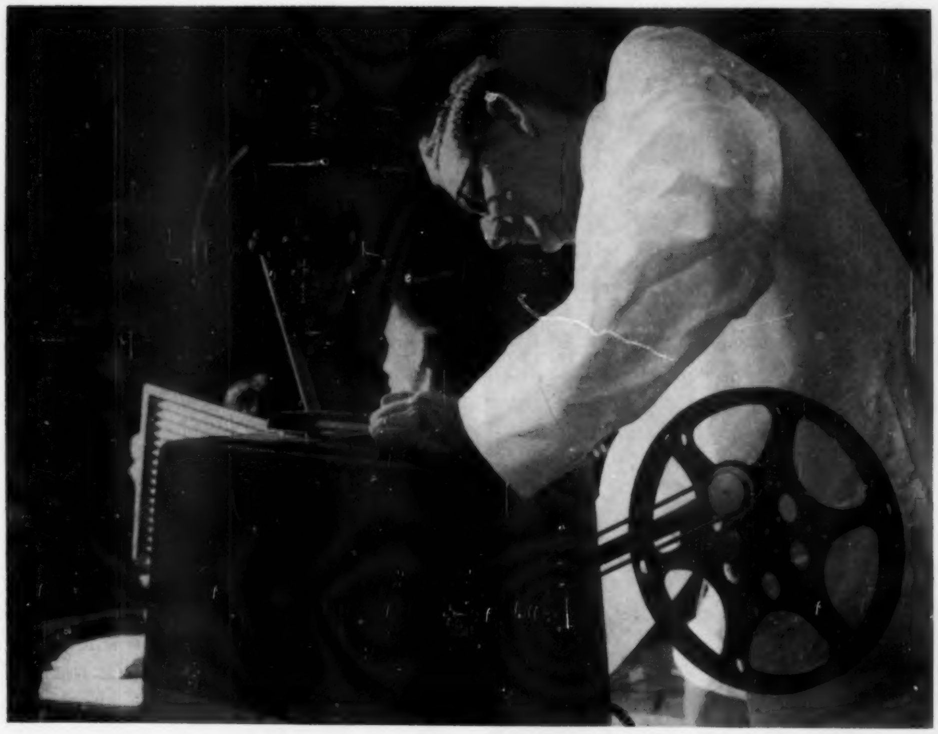
[1] Aurelio O. Elevazo. "A Content Analysis of Films Dealing with Educational Guidance in High School. Doctor's Thesis. Indiana University, Bloomington, Indiana. 1956.

[2] Robert A. Weisgerber. "The Effect of Science Motivational Films on the Attitudes of Secondary School Pupils Toward the Field of Science." Doctor's Thesis. Indiana University, Bloomington, Indiana. 1960.



All films were projected by the regular teachers in the classroom environment so that students were unaware of the experiment being conducted.

feelings toward his science classes, Part 1; use of films in science courses, Part 2; the work a scientist does, Part 3; and his science teacher, Part 4. The second instrument was the Kuder Preference Record (Vocational Form C), used as a measure of interest in science activities. Thirdly, a specially designed course-preference sheet was used to reflect each student's stated wishes for courses in the next term. In addition, follow-up, tape-recorded interviews with selected students gave a qualitative check on the experiment.

Two schools cooperated in the study. In a junior high school, four eighth-grade general science classes comprising a total of 112 students were used. In the senior high school, three biology classes of mixed ninth and tenth graders were used for a total of 72 students. Control and experimental sections were randomly selected in both schools. All students were soon to make course selections for the following term. In both schools advanced science course work was optional.

Control sections were shown three factual subject-matter films appropriate to their daily course work. These films were selected by their regular science teachers. Experimental sections were shown three science motivational films selected by the investigator using predetermined criteria and validated as to film type by a jury of science-communications experts and by the producers of the films themselves. In general, motivational films might be defined as those intended to encourage appreciation of science study and a science career.[3]

Pre- and post-test administration of the instruments gave difference scores for each individual in control and experimental groups. Statistical techniques applied to the data were the Chi Square Test and the Mann-Whitney U Test.[4] These nonparametric techniques were chosen because they do not require assumptions of a normally distributed population or of data that are interval in nature.

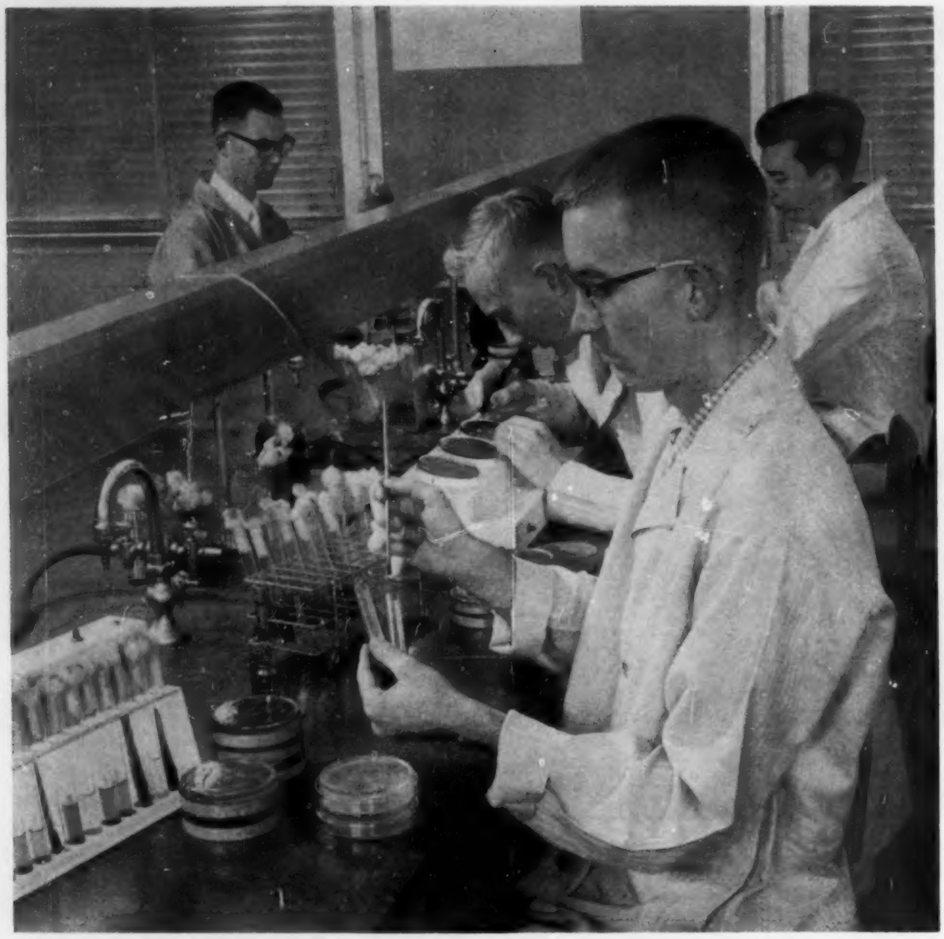
## Findings

Findings with respect to changes in *attitude* toward science are reported in Tables I and II. Their interpretation should be considered in the light of the limitations of attitude-scale analysis that depends so heavily on the students' accurate expression of their internal feelings. It is apparent in Table I that

Control groups were shown films based upon factual subject matter currently being studied as regular course work.

[3] The films classified as science motivational included "Career in Bacteriology" (Indiana University), "Engineering for Tomorrow" (North American Aviation), "Introduction to Chemistry" (Coronet Instructional Films), "Scientific Method" (Encyclopaedia Britannica Films), and "Why Study Science" (McGraw-Hill Text Films). The films classified as factual subject matter included "Insects" (Encyclopaedia Brittanica Films), "Life in the Sea" (Encyclopaedia Britannica Films), "Mammals Are Interesting" (Encyclopaedia Britannica Films), "Snapping Turtle" (Encyclopaedia Britannica Films), and "Wild Fowl in Slow Motion" (Hawley-Lord).

[4] Sidney Siegel. *Non-Parametric Statistics for the Behavioral Sciences.* McGraw-Hill Book Company, Inc , New York. 1956.



A scene from "Career in Bacteriology" (Indiana University) included in the motivational film battery.

the science motivational films were not a significant influence on science attitude formation in the case of the junior high general science students. As shown in Table II, they were significant in influencing senior high biology students' attitudes toward their current science classes but not effective in the other aspects.

Changes in *interest* in science activities were only investigated in the senior high group since the Kuder Preference

**TABLE I**

**Results of the Mann-Whitney U Test for the Science Attitude Scale (Junior High Students)**

| Instrument | Associated Probability | Significant Difference |
|---|---|---|
| Science Attitude Scale, Part 1 | .3015 | no |
| Science Attitude Scale, Part 2 | .1635 | no |
| Science Attitude Scale, Part 3 | .0869 | no |
| Science Attitude Scale, Part 4 | .4920 | no |

Record was above the level of the junior high participants. Findings are reported in Table III. The difference between control and experimental groups was a significant one, indicating that the students seeing the science motivational films were influenced favorably toward interest in science activities.

An interesting contrast was found between the junior high and senior high situations with respect to the effect of films upon students' further *selection of optional science courses*. The specially designed Course Preference Sheets required each student to rank the courses he would *like* to take for the following term. By noting changes in science rankings between pre- and post-tests it was possible to compare control and experimental groups in each school using the Mann-Whitney U Test as shown in Table IV.

Junior high students were making a choice between a science course that was terminal and one that indicated an intent to continue taking science throughout high school. Table IV shows that the experimental groups were significantly influenced by the science motivational films toward a greater preference for the academic science course leading to a four-year program of science study.

On the other hand, Table IV indicates that experimental senior high groups were not significantly more disposed toward selection of further science courses. These mixed ninth- and tenth-grade biology students were completing the year of science study required for graduation, and many of them were simply following a four-year program initiated the year before.

A Chi Square Test was used to treat Course Preference Sheet data in order to establish whether the films had a lasting effect, that is, whether the experimental students were more likely than control students to translate stated preference into actual selections when they later committed themselves for the following school term. Table V shows the findings of control and experimental group comparisons in the junior and in the senior high schools.

Table V shows that the junior high experimental students were significantly more inclined to "stick to their guns" on courses they had chosen than were the corresponding control students. The table also indicates that this was not true of the senior high students when both control and experimental groups were following commitments made a year earlier.

**Summary**

Students in junior high general science were approaching a course decision between selection of a terminal science course and one that led to further science study. Experimental students exposed to selected science

**TABLE II**

**Results of the Mann-Whitney U Test for the Science Attitude Scale (Senior High Students)**

| Instrument | Associated Probability | Significant Difference |
|---|---|---|
| Science Attitude Scale, Part 1 | .0066 | yes |
| Science Attitude Scale, Part 2 | .3557 | no |
| Science Attitude Scale, Part 3 | .4207 | no |
| Science Attitude Scale, Part 4 | .2546 | no |

**TABLE III**

**Results of the Mann-Whitney U Test for the Kuder Preference Record (Senior High Students)**

| Instrument | Associated Probability | Significant Difference |
|---|---|---|
| Kuder Preference Record | .0066 | yes |

motivational films were significantly influenced toward the selection of the more academic science alternative. Furthermore, they were significantly inclined to maintain their stated preferences when they made their actual choices a month later. They did not seem to be influenced more favorably toward the attitude objects: (1) science class, (2) seeing science films, (3) the work a scientist does, and (4) their science teacher.

Students in senior high biology were completing science graduation requirements and were following four-year programs planned at the beginning of high school. They could elect or reject advanced science study. Experimental students were not influenced toward selection of advanced science courses, nor were they more likely to maintain stated preferences when making their actual choices ten days later. However, they were significantly influenced toward a more favorable interest in science class. Other attitude factors—seeing science films, the work a scientist does, and the science teacher—did not seem to be influenced by the motivational films.

### Conclusions

Science motivational films appear to make particular contributions in junior and senior high science that are not accomplished by the use of factual subject-matter films.

In the junior high situation, these films serve the useful purpose of giving "structured information" to the students that will help them in forming clear evaluations about *future* science course selection. At this level, science motivational films are most useful as *informational devices* which bring students closer toward course decisions that are based on firm convictions.

In the senior high situation, science motivational films serve the useful purpose of giving students a renewed interest in their *current* science program of classes and activities. At this level, they are most useful as *inspirational devices* which give students an impetus toward immediate participation in science.

**TABLE IV**

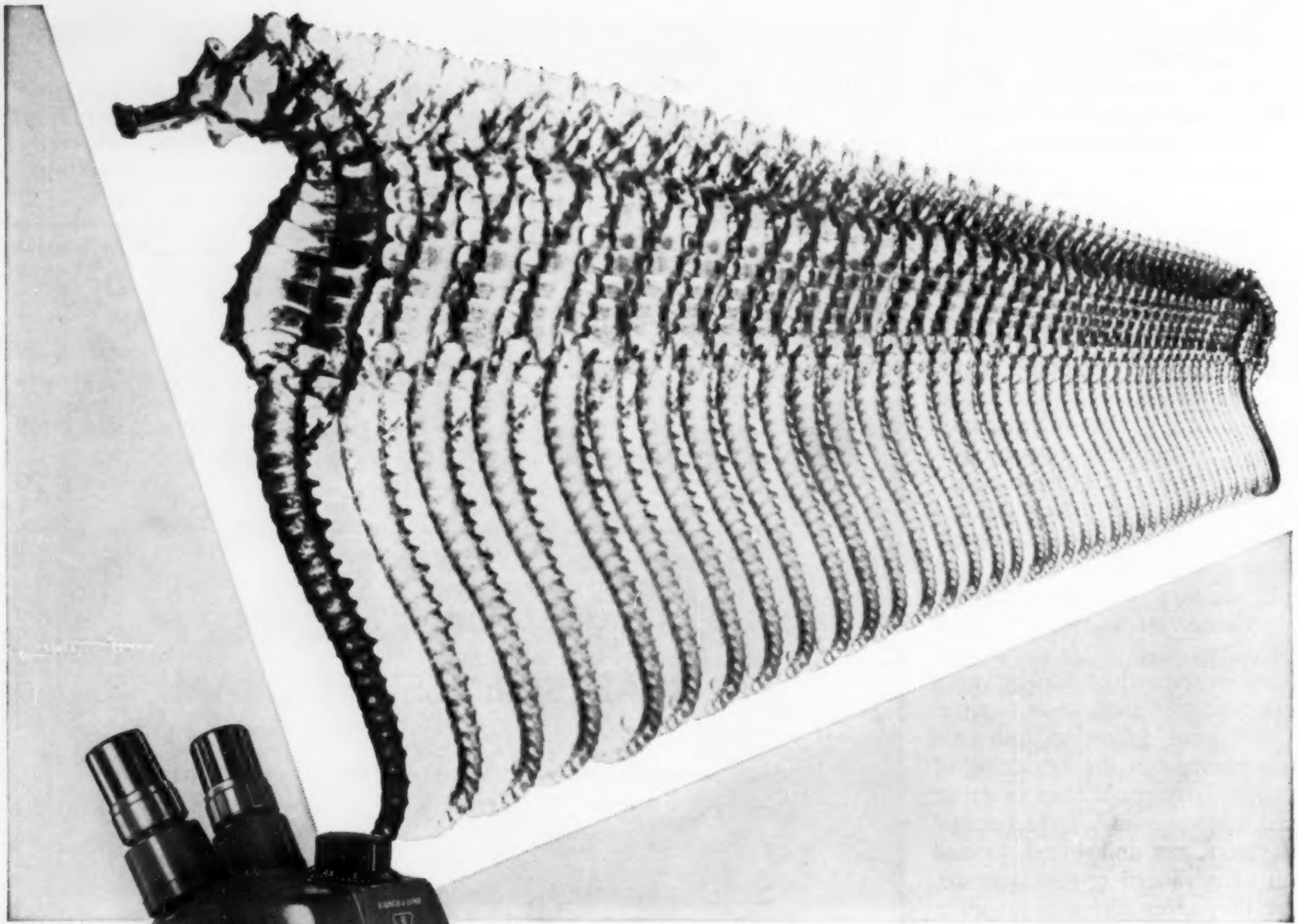
**Results of the Mann-Whitney U Test for the Course Preference Sheet (Junior High and Senior High Students)**

| Instrument | Grade Level | Associated Probability | Significant Difference |
|---|---|---|---|
| Course Preference Sheet | Junior High | .0071 | yes |
| Course Preference Sheet | Senior High | .2981 | no |

**TABLE V**

**Results of the Chi Square Test for Junior High and Senior High Students Who Maintained Their Post-test Course Preference When Making Actual Course Selections**

| Grade Level | Associated Probability | Significant Difference |
|---|---|---|
| Junior High | .05 | yes |
| Senior High | .475 | no |



# An Approach to Science Film Evaluation


**By RICHARD GILKEY**

Assistant in Selection, Audio-Visual Center, Indiana University, Bloomington, Indiana


*"I know what concepts I want to include in the next unit, but is there a more meaningful way to present them than I used last year?"*

This is a question asked by all teachers, and one that science teachers often find even more puzzling now when there is a rapid increase in the development of all types of instructional materials. Coupled with this increase in production of materials has been an increase in funds available to purchase materials. This has been the result of an increased allotment of regular school funds to science education, supplementary funds from Title III of the National Defense Education Act, or the combined effects of both.

The problem still remaining is how will the teacher select and recommend what is to be purchased or rented for use in his classroom. Publications such as *The Science Teacher* offer many helpful reviews of materials, but need for other sources of information on materials is evidenced by the requests of science teachers for assistance in selection of instructional materials.

### Development of the Program

To help this situation and at the same time to assist Indiana University in providing the best possible motion pictures through its film library service, a decision was made in September 1959 to send a representative (the author) into the field to work with science teachers in selected high schools in Indiana. Schools in nine Indiana cities were involved, and committees were established of teachers from single schools or a city-wide group involving teachers from a number of schools. The author and members of the Center's staff met with each group in January 1960 to begin activities and to explain purposes of the project. At this meeting, a recently released science film was shown and evaluated in terms of general criteria for educational films and specific criteria especially related to science films.[1] Following this meeting, each school received a film about every week or two during the remainder of the school year.

During the period from February through the end of April, twenty-nine films were evaluated by an average of three committees each. The films remained in each school about one week and could be used by the teacher in his class if desired and if appropriate to the subject matter currently being studied. In some committees, films were previewed by the entire evaluation committee, and in others individual previewing was more common. Modified Educational Film Library Evaluation forms on which all bibliographical information and a synopsis of the film content were prerecorded served as instruments for each individual to report his own reaction to the film.

In addition to providing a means for reporting reactions to the film in terms of instructional purposes, the form made provision for the teacher to indicate activities that could accompany

[1] Copies of these criteria are available upon request to the author.

use of the film, how these activities compare in effectiveness with the film, and whether or not that teacher would use the film.

Film shipments originated from the Center and were sent to each school selected for evaluating that title. The schools then circulated the film to each successive committee in accordance with directions received from the Center. The last school returned the film to the Center.

When the films had been evaluated by the committees, reports of the evaluations were summarized into objective-descriptive and subjective-appraisal sections. The first section includes the title, bibliographical data, and a synopsis. The latter presents recommended grade levels, lists of topics covered, the instructional purposes, strengths and weaknesses, and integrative activities suggested for use with the film. Under topics covered, an asterisk is used to indicate those topics stressed in the film. Underlined grade levels designate those which evaluators cited as primary audiences for the film.

The appraisals summarize closely related opinions using a consensus statement, but report diverging ones separately. The divergences in evaluation may be attributed to several factors including (1) the philosophy of education held by the teachers, (2) the ability level of the pupils with whom the teacher works, and (3) the lack of laboratory equipment necessary to follow up ideas in the film or the presence of equipment with which the teacher can provide the experience without the film. No attempt has been made to pull together evaluations on a single film to arrive at an over-all rating of a film's purposes, strengths, and potential utilizations.

It is hoped that appraisals can serve to guide science teachers in film selection based on personal educational objectives and the relation of these objectives to the film's audiences, purposes, and potential utilizations.

### Summary of Project Outcomes

Evaluation being a subjective process, no effort has been made to draw any objective summary from the evaluations. Certain trends, however, were evident:

1. Evaluators expressed an approval for those films carefully organized around only a *few concepts* that can be easily integrated into the instructional program.
2. Several evaluators rated highly those films that offered demonstrations normally done by the teacher, but presented more concisely and effectively by the motion picture media.
3. There was general agreement that the majority of films previewed were of high technical quality and offered pupils observations, experiences, and conciseness of presentation not otherwise available.
4. The most frequent weaknesses cited were too rapid development of content and attempts to cover too many concepts in a single film.
5. Films that did not present actual explanations, but rather attempted to broadly motivate pupils or survey an extensive field of knowledge, generally did not rate favorable reactions. This includes the film biographies of scientists. An exception noted to the generally unfavorable reaction to motivational or survey films were those of outstanding film treatment such as *World in a Marsh, Spruce Bog: An Essay in Ecology,* and *From Generation to Generation.* These productions were of such outstanding quality and did so effectively build certain attitudinal concepts that they would serve to meet instructional needs as defined by the evaluators.
6. A demand was evidenced for films on single rather than multiple concepts and for film development of a less rapid pace so that pupils would not become confused by the complexity of the subject matter.
7. The evaluations provided by the state-wide committees have directly influenced the Center's selections of some titles and indirectly affected many others.

As a result of a series of follow-up meetings with all committees during Spring 1960, and experiences gained through the first year's activities, the second year of the project followed several newly defined guidelines:

1. Films of a highly specialized nature should be evaluated only by teachers in that subject-matter area, thereby increasing the validity of the appraisal.
2. Student reactions to films, when available, should receive some consideration in the final report and also be identified as student reactions. The decision to solicit student reactions rests with individual committee members.
3. The administrative procedures used the first year required no major administrative alterations for this year's activities.
4. All schools participating the first year agreed to work on the project a second year, and one new school was added this year.
5. A series of state-wide regional intrastate meetings is being investigated at the request of several individual school committees. These would be similar to workshops and involve problems relating to the selection and utilization of science films.

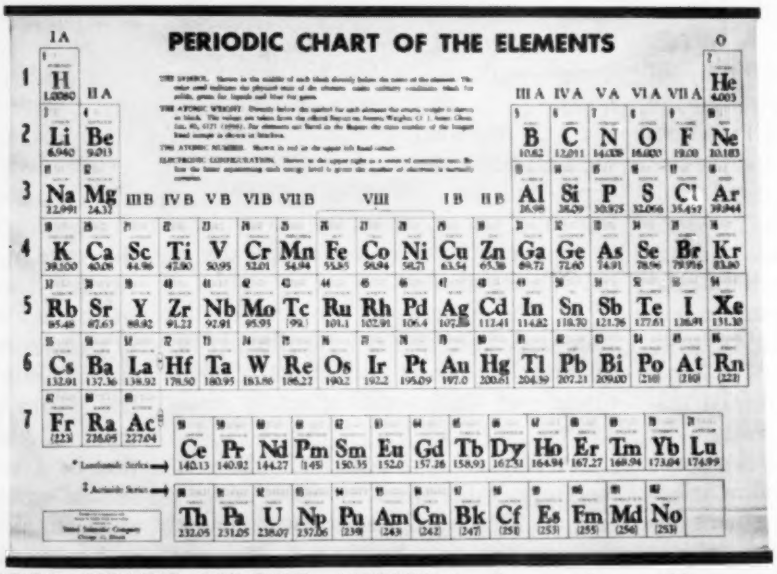
### Achievements Realized

The success of the first year's activities achieved the results which the university expected for the project and was sufficient to warrant carrying the project ahead for a second year, adding a parallel film-evaluation organization in high school social studies.

This field-service activity was the culmination of a number of concurrent factors. For several years, the Audio-Visual Center of Indiana University has realized the advantages of involving a wider group of individuals in the process of evaluating new films for addition to the library and re-evaluating films now among the nearly six thousand titles already within the Center's collection. Because the film library serves the entire state of Indiana and curricular needs vary from one school in the state to another, Indiana University felt it would be advantageous to be in contact with the needs and interests of classroom teachers in all parts of the state. Additionally, the larger evaluative group would offer a greater spectrum of judgments. Through stimulation by a variety of materials, teachers should see some new uses for films and suggest areas in which films are needed to improve instruction.

It was hoped that teachers having the opportunities to see what is available to them on film would increase their knowledge about current films and consequently improve their utilization. A further expectation was that the teachers and school systems selected would share their reactions and information with others thus enabling them to select and use classroom films more effectively. This latter goal is partially satisfied in the series of twenty-nine


9420. STANSI MOLECULAR MODELS for individual student manipulations. Consists of 54 one-inch hardwood enameled balls of seven colors drilled to receive one and two inch wood pegs. Helical springs, two inches in length, are supplied to represent multiple bonds and for forming ring structures. Complete with attractive box and instructions.
$4.50 each 6 sets $4.00 each 12 sets $3.85 each




7825. PERIODIC CHART OF THE ATOMS in four colors. The modern long form showing 102 elements, their atomic weights, numbers, and configurations. Gases are shown in blue, liquids in green, and solids in black. Atomic weight, number and symbol visible across the laboratory.

Lithographed on heavy gloss paper 42″ x 58″. Wood rollers at top and bottom. $6.00

7824. CHART, ATOMIC WEIGHTS. A chart 30 x 45 inches on chart paper mounted on common rollers. An alphabetical list of all elements giving their symbols and atomic weights.......................................$3.50

**STANSI SCIENTIFIC COMPANY, 1231-41 North Honore St., Chicago**

film evaluations supplied to participants by the report of the first year's activity.

Until last year, the film-evaluation process at the Center involved group interaction of subject-matter specialists from the University faculty or the Center, teachers in University High School, and graduate students in audio-visual communications or subject-matter areas represented by the content of the film being evaluated. This evaluative process had proven satisfactory within its defined limits—that of giving the Audio-Visual Center a basis for adding films to the library using the criteria of accuracy of content, ability to perform an instructional function with a target audience, and adequate use of the film medium. In addition, it provided the faculty, staff, and graduate students the opportunity of a firsthand acquaintance with new educational motion pictures.

Another foundation on which this project has a basis was cited by Neal Miller.[2] He stated that there is a need for teachers to see key films, filmstrips, and slides in their areas of teaching and that there is a responsibility for assembling and showing superior materials within a certain subject-matter area to those responsible for its instruction. Through interpersonal communication, the effects of this type of previewing can spread far beyond the immediate groups involved.

Junior and senior high school science was recommended as a field with which to begin this program since a number of the Center's personnel have training in science and/or have been high school science teachers. These individuals did serve as resource persons in structuring the project's activities. Additionally, the emphasis placed on science in present educational thinking and the efforts being made to improve science education under the National Defense Education Act, the National Science Foundation, and various nongovernmental groups influenced the selection of this curriculum area.

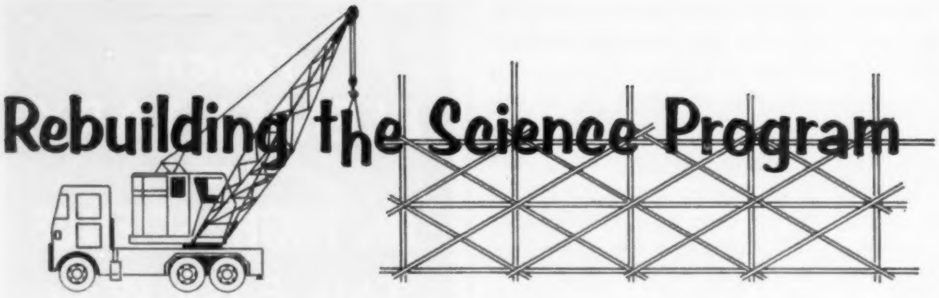
**Suggestions for Wider Implementation**

While the scope of this project involved only a limited number of schools in one state, an activity of this nature could be organized in other states, metropolitan areas, or city systems, and the resulting reports would provide teachers with considerable data of value in improving film selection and utilization. If interest is sufficient, a similar national evaluative program for all science instructional media might offer teachers assistance in answering the question: "I know what concepts I want to include in the next unit, but is there a more meaningful way to present them than I used last year?"

A copy of the report to the evaluation committees containing appraisals of the twenty-nine films listed below is available upon request to the author.

"About the Human Body"
Churchill-Wexler Film Productions
"Acids, Bases, and Salts"
Coronet Instructional Films
"The Arctic: Island of the Frozen Sea"
Encyclopaedia Britannica Films
"Battle of the Bugs"
Ken Middleham
"Circulation: Why and How"
Churchill-Wexler Film Productions
"The Colloidal State"
Coronet Instructional Films
"Copper: Steward of the Nation"
Avalon Daggett Productions
"Frog Anatomy"
Indiana University
"From Generation to Generation"
McGraw-Hill Text Films
"Fundamentals of the Nervous System"
Encyclopaedia Britannica Films
"Galileo"
Coronet Instructional Films
"Glaciers"
Northern Films
"How Do We Know the Earth Moves"
Film Associates of California
"Introduction to Jet Engines"
McGraw-Hill Text Films
"Ionization and Ionic Equilibrium"
Indiana University
"Isaac Newton"
Coronet Instructional Films
"Nitric Acid Compounds and the Nitrogen Cycle"
Coronet Instructional Films
"Osmosis"
Encyclopaedia Britannica Films
"Platform and Triple Beam Balance"
University of Southern California
"Principles of Endocrine Activity"
Indiana University
"Principles of Nuclear Fission"
McGraw-Hill Text Films
"Rockets and Satellites"
International Film Bureau, Inc.
"Solutions"
Coronet Instructional Films
"Spruce Bog: An Essay in Ecology"
McGraw-Hill Text Films
"Stars and Star Systems"
Encyclopaedia Britannica Films
"Vacuum Practices"
McGraw-Hill Text Films
"What's Inside the Earth"
Film Associates of California
"World in a Marsh"
McGraw-Hill Text Films
"X-Ray Crystallography"
McGraw-Hill Text Films

[2] Neal Miller. "Graphic Communications and the Crisis in Education." *Audio-Visual Communication Review*, Vol. 5, No. 3. 1957.




## Space Science

# The Three E's: Examination, Experimentation, and Evaluation

By PAUL E. SCHIELE, JR.

Science Coordinator, Ontario School District, Ontario, California

CHILDREN today are living in a complex civilization, and it is becoming increasingly important that they develop a basic understanding of their environment if they are to adjust to the complexities of an adult world. In this era of scientific exploration, resulting in part from the advent of the American and Russian satellites circling our earth and sun, the elementary school teacher has a wonderful opportunity to initiate and stimulate her students' interest in and respect for the field of science.

The author (right) teaches and orients the sixth graders to a space lecture through the use of models and pictures from text references.

An introduction to space science, capitalizing on an interest already developed, could provide the springboard for further investigations and experimentations in other areas of science. In presenting the unit on space, a favorite method of the writer has been to study the function and use of the various instruments which man utilizes to explore the universe.

Most students in the upper elementary grades can understand the basic structure and function of the following tools of the space investigator:

1. The reflecting and refractory telescopes.
2. The rocket and related instruments.
3. The man-made satellite and component parts.
4. The weather balloon and corresponding instruments.
5. The prism within a spectroscope.

A study of space instruments affords the teacher an opportunity to have his students construct and work with their own models, projects, or instruments. Their written studies seem to have more meaning, and their horizons of understanding are enlarged.

My sixth-grade class began their study by first getting a concept of the vastness and size of the universe. Then, the class conducted an extensive investigation of the instruments which scientists utilize when exploring the depths of outer space. Before the actual unit was introduced, a class discussion was held to determine the specific problems which were to be solved. It was decided that the class would form committees limited in number to two or three so that each student could participate actively. Committees were established according to related interests in a specific area of man's investigation of space.

One group expressed the desire to work with a model of the 200-inch Palomar Reflecting Telescope. Another committee decided to construct their own refractory and reflecting telescopes. Some students decided to build a satellite containing a mock-up of the various instruments needed in a satellite. Others worked on models of rockets, planets, constellations, the sun, and moon.

One group even decided to construct a paper balloon which could be utilized for weather investigations.

Construction did not begin until all

committee members had completed some fundamental reading on their specific problem. When the construction phase was completed, each group prepared a report to be presented to the class with a demonstration of their project.

For the culmination of our space study, we viewed an excellent color film that illustrated and explained the function of the instruments which scientists utilize in their endless search of the heavens and their environment.

Through this unit, many basic principles of space were introduced to the pupils. The scientific approach appeared to be better understood as a result of the practical applications which were shown.

Although the program herein described is brief, it is hoped that this article will offer suggestions to the new teacher for elementary activities in science. As a tested method in examination, experimentation, and evaluation, it has proved of much value to stimulate classroom interest.


Sixth-grade pupils work directly in the construction of models, instruments, planets, and related space equipment planned under the project activities.

## • • • *Rebuilding the Science Program* • • •

**General Science**

# Use of Science Teams

**By ARTHUR R. SCHIFFER**

Head, Science Department, Lithonia High School, Lithonia, Georgia

**This report was an entry in the 1960 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.**

IN an effort to develop more interest in all the science fields, the science department at Lithonia High School has established seven traveling science teams. Using the high school as their home base, these teams make their own preparations, build their own apparatus if necessary, and conduct their own experiments. Then, upon request of any elementary school in the Lithonia area, they visit the various grades and demonstrate a field of science through experiments.

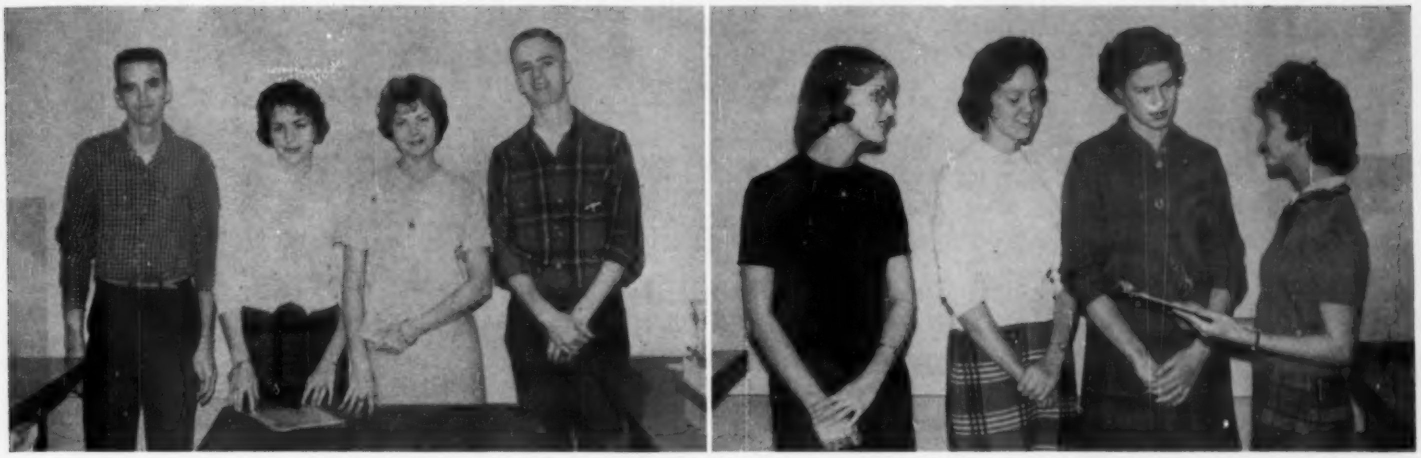
The values to be gained from such a program are as follows: (1) the team members learn through experiences in teaching; (2) elementary students sense the enthusiasm of the team and desire further knowledge; (3) teachers who feel an inadequacy to teach science effectively learn by observing; and (4) potential scientific aptitudes are tapped when students showing a deep interest are encouraged to come to the high school for further study under proper guidance.

For the past four years, Lithonia High School has experimented with different methods in teaching and encouraging students to pursue additional courses in mathematics and science. It was not, and still is not our intention to produce scientists, rather to encourage scientific interest.

Our progress in this respect has been notable. The college enrollment has doubled, and failures in college have decreased to less than one-half per cent.

This year we completely revised the work of our science teams, placing more emphasis upon scientific thinking and follow-through. In all instructions, team members were to emphasize the value of scientific thinking.

The over-all objective is to help students in acquiring factual knowledge; to enable them to distinguish causes, recognize results, and significant patterns; to read and understand material in a discriminating way; and to write effectively and intelligently about what they see, what they hear, and what they learn. In addition, we are teaching them to relate scientific data and problems, to arrive at conclusions based on facts and not prejudice, to organize their thoughts, and to marshal supporting truths. We have attempted to excite the interests of the students and to create a thirst and curiosity for science.



The working groups: The Senior Coordinators complete a discussion; the science journalism staff and recording secretaries confer.

It is not enough to demonstrate scientific knowledge or explain it, to write about scientific facts, or to excite interest in scientific facts; but it is essential that every member be able to organize all such information and crystallize it through research. We think that if a student, or a group of students, does research purely for the sake of investigating, comparing, and trying new methods, then he will learn.

The following outline is the working draft made by the coordinating committee:

*Problem:* How our teams can, in their instructions to the lower grade levels and the junior high school students, demonstrate an area of science and at the same time show the use of scientific method through this instruction.

Group discusses possible methods of securing, drying, and pulverizing animal tissue for use in project on cancer.

*Materials for Student Lecturers:*

1. Forms and outlines for studying science.
2. Team project forms coordinated to insure against needless repetition.
3. Equipment to excite interest. Equipment, whenever possible, should be homemade or improvised.
4. Time-budgeting forms.
5. Description of scientific study.
6. Forms for scientific method in equipment storage.

*Action:*

1. Teams were assigned and coordinators elected.
2. Miscellaneous equipment was secured.
3. Advisory council screened the science projects presented by science teams the previous year.

Four science teams meet with understudies (seated in front row).

(Advisory Council consisted of coordinators.)

4. Projects were assigned according to interests, with this exception: the junior team had to take projects that were not of their choosing; however, upon demonstration of ability in research, the junior team will then be permitted to take work more to their liking.
5. Goals established.

*Project Assignments:*

Team 1—Growth of Tissues in Different Medias.
Team 2—Study of Skin Cancer.
Team 3—Lung Cancer.
Team 4—Tumors (Brain).
Team 5—Heart Diseases.
Team 6—Blood Cancer.
Team 7—Effects of Neucleonics on Animal Tissues.
Team 8—War and Peace in Science.
Team 9—Intelligence determined by Color Preference.

**NOTE: Further information on each of the team projects may be obtained from the author.**

*Check List Form:*

I. Background — Work of the previous year.
II. Errors—Corrections and study of methods used.
III. Problems.
IV. Materials Needed for All Teams—tentative. (Dependent on current projects.)
   a. Laboratory animals and cages.
   b. Band Aids—tough skin.
   c. Nicotine tars.
   d. (1) Pulverized placenta.
      (2) Animal sperm.
      (3) Sterile gauze.
   e. Cooler box.
   f. Incubator.
   g. Check list.
   h. Anesthesia.
   i. Audio-visual equipment.
   j. Geiger counters.
   k. Radioactive foods and iodines.
   l. Freezer.
   m. Cooler box (for transportation of material).
   n. Sliding microtrome.
   o. Mounting equipment.
V. Procedure—based upon previous experience and the applications of scientific methods.
VI. Results.
VII. Conclusions.
VIII. Opinions.
IX. Final decisions concerning conclusions and opinions to be recorded during and at the termination of a group's work.

**Conclusion**

For the past four years, we have considered using high school students as student lecturers and demonstrators. Although this program has not been effected, teams have presented assembly programs at six-week intervals. A different approach is used in each assembly, but all end with a short lecture designed to stimulate the curiosity of the audience.

The science team waiting list is large. Each team has its understudies, and they contribute to the success of the program.

Our science teams have become extremely popular. Science at Lithonia is no longer "just a required subject."

• • • *Rebuilding the Science Program* • • •

Biology

# The Accelerated and Enriched Biology Course

By ARTHUR H. ULRICH

Science Teacher, Setauket School, Setauket, New York

IN response to a specific need which developed through the establishment of an accelerated-enriched science program for the gifted student at Massapequa High School, Massapequa, New York, the following study was initiated.

**NOTE: This course of study was used in partial fulfillment of the degree for Doctor of Education, Teachers College, Columbia University, New York City.**

Both professional literature and syllabi were examined to determine a comprehensive course of study in biology, designed for a broader understanding and a greater depth of coverage. The resultant course was submitted to a group of college and high school biology teachers for suggestions or possible revision. Although their comments ranged from ultraconservative criticism, through general agreement, to major alterations in format, two specific changes were suggested: (1) minimize the traditional phylogenetic approach and (2) structure the entire course content around the central theme of evolution.

The course of study which follows was implemented during the 1958-59 school year.

**Unit I. The work of the scientist—an introduction.**

A. What is science?—a way of producing workable conceptual schemes.
B. The historical development of the life sciences.
C. Evolution—the biologist's working hypothesis.

**Unit II. The uniformity of life.**

A. Life processes.
B. The cell—life's basic unit.
C. The nature of protoplasm (physical and chemical aspects).

### Summary Program for Secondary School Science Teachers

The Oak Ridge Institute of Nuclear Studies will offer an extensive science demonstration lecture program for secondary school science teachers. This program will be held from June 19 to September 15, 1961. Information can be obtained from the University Relations Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee.

Applications should be received by not later than April 15. Announcement of final selectees wil be made by May 15, 1961.

**Unit III. The maintenance of life.**

A. Plant and animal nutrition (the work of the cell).
B. Self-maintenance—a comparative study in an evolutionary context.
C. Behavior of living things.

**Unit IV. The variety of life.**

A. Classification (grouping for simplicity).
B. Simple plants.
C. Complex plants.
D. Simple animals (significant evolutionary aspects).
E. Higher animals (significant evolutionary aspects).

**Unit V. Survival of life.**

A. Reproduction—the propagation of the species.
B. Development and growth.
C. Genes and heredity.
D. Evolution.

**Unit VI. Interdependence of life.**

A. Life through time.
B. Ecological relationships.
C. Conservation.

#### Implementation

At Massapequa, gifted students are selected early in the seventh grade for participation in an accelerated-enriched program on the basis of their achievement, intelligence and reading test scores, teacher recommendations, and parental consent. The students may be accelerated in any or all subjects for which they qualify. Approximately forty-five general science students, less than ten per cent of the entire seventh-grade student body, were selected and completed three years of general science in two years. Thirty-seven of the above students were used in this study, and, as eighth graders, all scored within the 95 to 99 percentile rank on the New York State Science Survey Examination given normally at the end of the ninth year. Thus, as ninth graders, these students were ready to take tenth-year biology. The students possessed high IQ's (base 120 on California Test of Mental Maturity) and a reading level averaging two years above the normal level. The class met seven periods a week for forty-five minutes each, with at least three periods allocated for laboratory work.

#### Evaluation

Objective and subjective evaluation of the effectiveness of the course was determined using the New York State Biology Regents Examination, pre-test and post-test; the Nelson Biology Test, pre-test and post-test; a questionnaire promulgated by the investigator; and student achievement for the course. The Nelson Biology Test was particularly suited for use in this study since norms or levels of expectancy had been established for the general high school population as well as for specific intelligence quotients of tenth-grade students who had completed a gene-al course in biology.

When pre-tested on a past Biology Regents, the students in the study attained an average grade of fifty-two. Upon completion of the course, the average grade was above ninety, and a few perfect papers were written.

When pre-tested by the Nelson Biology Test, the students scored in the sixty-sixth percentile rank compared to the national norms of their intellectual equals and in the ninety-fourth percentile rank when compared to the general high school population. Both of the norms were based upon students who had already completed a biology course and who were at least one year older than the students used in the study. When post-tested, the average result was in the ninety-third percentile rank when compared to the normative group who had similar intellectual equipment. On this same post-test they scored over the ninety-ninth percentile rank when compared to the general high school population in the normative group.

## Conclusions

A noteworthy and often overlooked consideration when planning for gifted children is the diverse background which they bring into a course. The children used in this study knew more about the principles, applications, and facts of biology before taking the course than did ninety-three per cent of the students in the normative group on the Nelson Biology Test who had already completed a biology course. Ignorance of such a background may cause some teachers to plan far below the abilities of the students and in effect try to teach them what they already know. In general, this situation is apparent to me in too many classrooms, and with the resultant lack of stimulation given to the student, boredom and under-achievement may occur. The results of the Nelson Biology Test indicated this. The students used in this study scored well on both the pre-test and post-test when comparisons are made with the norms of their intellectual peers. Thus, one finds cause to question the biology course offerings which were used in the standardization of the test in the sixty-three schools representing twenty-seven states. Many of these schools were obviously not developing the intellectually gifted student sufficiently in the area of biology. Moreover, these results tend to show a need for and the value of accelerated-enriched courses, where the students are homogeneously grouped according to their ability. It would be very difficult to meet the educational needs of gifted students, if they were a small minority in a class of students of average ability.



# PHYSICAL PROPERTIES OF LIQUID MIXTURES

By ALLEN L. HANSON

Associate Professor of Chemistry, St. Olaf College, Northfield, Minnesota

**The study of properties of liquids is limited in the laboratory to a number of routine investigations. Many of these investigations may be verified in the literature or handbooks. The author describes and graphs the results of experiments relating to the measurements of liquid properties, e.g., surface tension and viscosity. The study is begun with the introduction of unknowns in order to afford opportunity for accuracy and precision. From the data, the students are expected to interpret and draw conclusions and correlate the data with known theory or findings.**

OF the different states of matter, liquids are generally less understood than gases or solids. Different gases tend to behave in a similar fashion and may be described by a common gas law, modified to allow for deviations. Solids may be explored and characterized by X rays due to the relative immobility of their constituent atoms or ions. Pure liquids, on the other hand, may be described and identified only empirically through their characteristic physical constants, such as temperatures of phase transitions, refractive indices, surface tensions, and others. Liquids do not obey a common equation of state. Their unique viscosities, vapor pressures, and other properties must reflect various combinations of escaping tendency (*i.e.*, repulsion) and restraining tendency (*i.e.*, cohesion). Theoretically, the former may be calculated in terms of the temperature-dependent molecular kinetic energies of liquids. To some degree the cohesive forces, too, can be predicted, *e.g.*, for liquids such as water which exhibit considerable hydrogen bonding. Interpreting experimental data, one may surmise that liquids having high vapor pressures lack strong intermolecular attractive forces or conversely possess marked repulsive forces. In experiments dependent on other factors, the observations are not easily predicted.

The combinations of forces become more interesting when two liquids are mixed. If one liquid serves merely as the diluent for the other, the properties of the mixture should be additive. Thus the vapor pressures, for example, obey Raoult's Law. Figure 1 shows on the dotted curves that for a mixture of Liquids A and B, the vapor pressure of A increases from zero to that of pure A (*i.e.*, $p^0_A$) as the Mol fraction of A in the mixture increases from zero to one, and the pressure of B follows a similar pattern. The over-all vapor pressure of the mixture follows the straight line from $p^0_B$ to $p^0_A$ for an *ideal* liquid pair. This supposes that intermolecular forces between unlike molecules A-B are equal to an average between A-A and B-B forces. If A and B molecules have less attraction for each other than this average, a *positive* deviation results (upper curve in Figure 1), and if they have greater attraction than the average, the deviation is *negative* (lower curve). If strong deviation is evident in the ideal curve, the solutions may exhibit maximum or minimum boiling points (azeotropes). At

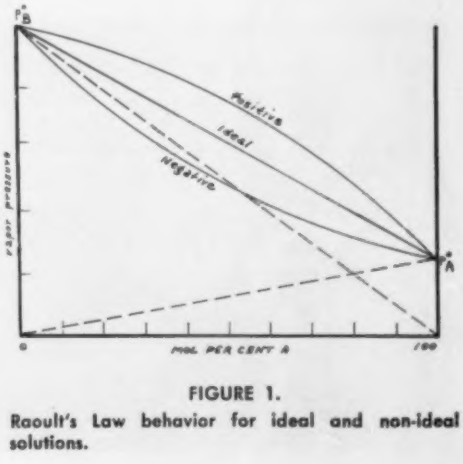



FIGURE 1.
Raoult's Law behavior for ideal and non-ideal solutions.

**NOTE: The author may be reached at the Department of Chemistry, University of Wisconsin, Madison, during the current school year.**

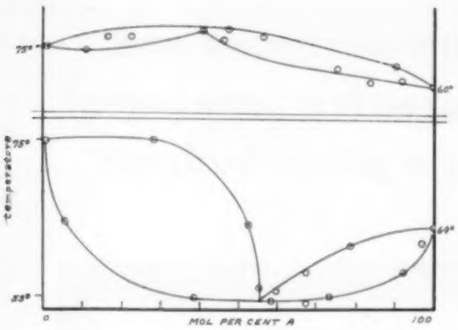



FIGURE 2(a).
Liquid-vapor equilibria for liquid mixtures. Upper diagram A—Chloroform, B—Ethyl acetate; lower diagram A—Methanol, B—Carbon tetrachloride.

these points boiling will give vapor of the same composition as the liquid. In general, however, the vapor has a different composition from that of the liquid, being richer in the more vola-

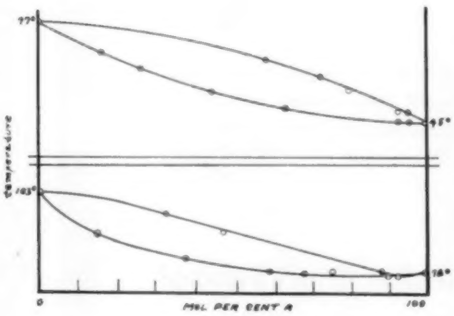



FIGURE 2(b).
Liquid-vapor equilibria for liquid mixtures. Upper diagram A—Carbon disulfide, B—Benzene; lower diagram A—Isobutyl alcohol, B—Benzene.

tile component. Figures 2 (a) and 2 (b) show examples of various intermediate-boiling and azeotropic liquid pairs. Note that they vary considerably in the separation of the liquid and vapor curves. In general, as would be expected, homologs or other similar compounds give intermediate-type curves (no azeotropes) and show the smallest separation of liquid-vapor curves.

Other properties of liquid mixtures

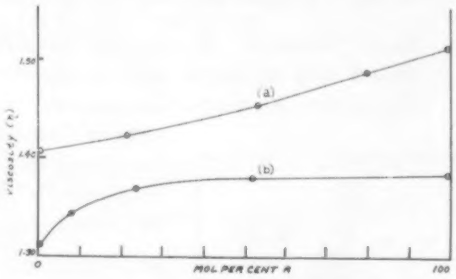



FIGURE 3.
Refractive indices of liquid mixtures: (a) A—Benzene, B—Isobutyl alcohol; (b) A—Isopropyl alcohol, B—Water.

are usually more difficult to predict, except that refractive indices vary linearly between those of pure liquids, as shown by isobutanol-benzene on Curve (a) of Figure 3. This linearity makes the refractive index a useful quantitative measure of concentration of a binary system. There are exceptions, however, as shown by isopropyl alcohol-water in Curve (b) of Figure 3.

Variation of surface tension with

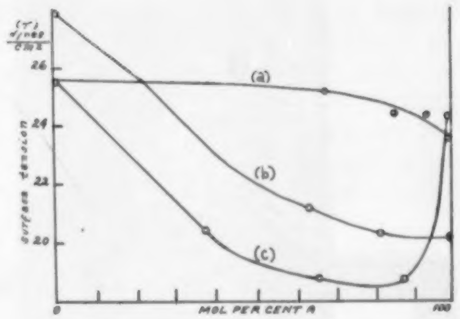



FIGURE 4.
Surface tension of liquid mixtures: (a) A—Methanol, B—Carbon tetrachloride; (b) A—Heptane, B—Benzene; (c) A—Methyl acetate, B—Isopropyl ether.

concentration frequently shows a small negative deviation, seen in Curve (a) of Figure 4 for heptane in benzene. This is in harmony with the Gibbs generalization that solutes usually lower the surface tension. Some pairs, *e.g.*,

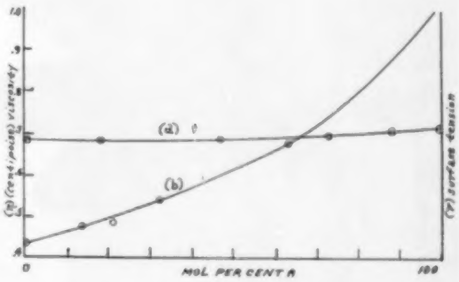



FIGURE 5.
Viscosity of liquid mixtures: (a) A—Xylene, B—Benzene; (b) A—Carbon tetrachloride, B—Carbon disulfide.

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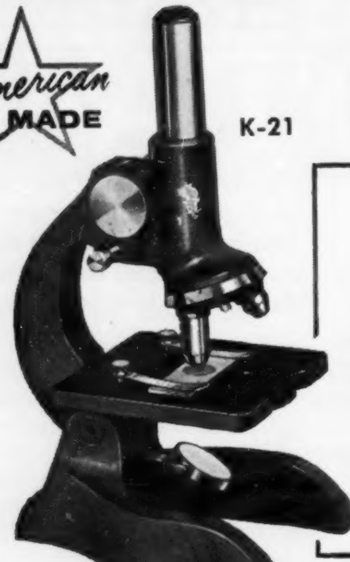
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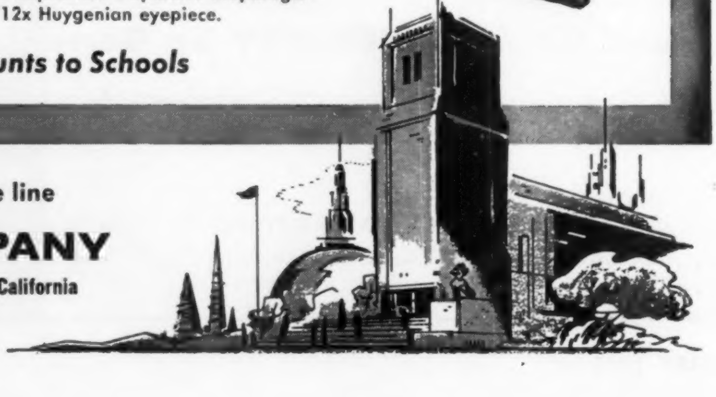

methanol in carbon tetrachloride—Curve (b)—give a slight *positive* deviation. Curve (c) shows a pronounced curve minimum in the case of methyl acetate in isopropyl ether.

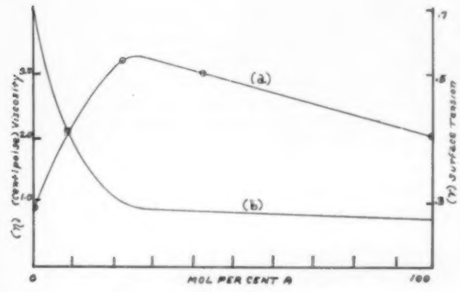


FIGURE 6.
Concentration effect on viscosity (η) and surface tension (γ) of liquid mixture A—Isopropyl alcohol and B—Water.

Viscosities may show extreme effects ranging from negative deviations, *e.g.*, for carbon tetrachloride in carbon di-

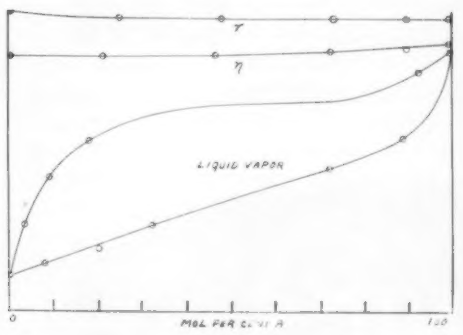


FIGURE 7.
Physical properties composite of liquid system A—Xylene, B—Benzene; top—surface tension, middle—viscosity, bottom—liquid-vapor equilibrium.

sulfide, to sharp maximum for alcohol-water mixtures. Curves (a) and (b) in Figure 6 relate such a maximum to a corresponding break in the surface tension curve. Figure 5 shows a more usual viscosity behavior.

A few composite graphs are shown, comparing different physical properties of a system. Figure 7 portrays a pair of "likes," *i.e.*, xylene-benzene; and dissimilar liquids methanol and chloroform are shown in Figure 8. Sometimes there is parallel behavior between different properties, sometimes not.

All these variants provide interesting experiments, particularly if the liquids are "unknown." The value of this approach to the study of liquids has been reported by the author[1] in connection with laboratory work in physical chemistry. A study of physical properties, however, can make an interesting project in itself by seeking to explain the peculiarities of liquid mixtures.

In addition, the experience of graphing data and interpreting them is valuable.

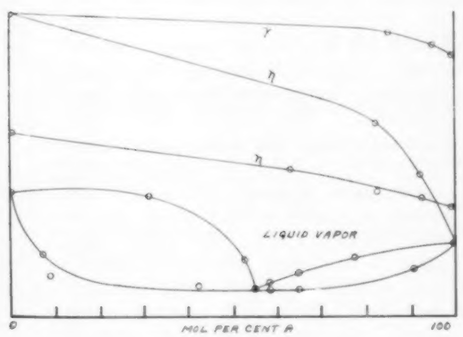


FIGURE 8.
Physical properties composite of system A—Methanol, B—Carbon tetrachloride. In order from top: surface tension, viscosity, refractive index, liquid-vapor equilibrium.

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[1] Allen L. Hanson. "A Laboratory Study of Liquid Pairs." *Journal of Chemical Education*, 37:143. March 1960.


# The Gifted Academic Underachiever

By EDWARD FRANKEL

Assistant in Research, Bureau of Educational Research, Board of Education, New York City

THE purpose of this paper is to present some recent findings related to the academic underachievers, and it is hoped will give teachers a better understanding of such phenomenon. In addition, some approaches and techniques for ameliorating the effects of scholastic underachievement are suggested to minimize our present loss of talent, as well as the deep personal frustrations resulting from failure of self-realization.

The intelligent youngster whose academic performance is well below the level of his measured capacity is no longer explained away with adjectives such as "lazy," "indifferent," "uninterested," or "uncooperative." Recent research efforts, triggered in part by the realization that our most important national asset and natural resource, brainpower, is not being completely utilized, are attempting to penetrate behind such superficial descriptions of school behavior and to find causes of academic underachievement. The accumulated evidence points to numerous causal relationships. Scholastic underachievement has been characterized as "a phenomenon which has etiological kinship with more obvious forms of social incompetence and maladjustment," which is "related to basic personality structure, not easily modifiable."

**Articles for this series are prepared under the direction of Research Committee chairman, Dr. William B. Reiner, Bureau of Educational Research, Board of Education, New York City. Author credit is given for each article in the series. Committee members serving this year include: Cyrus Barnes, New York University, New York City; Sam S. Blanc, Gove Junior High School, Denver, Colorado; Fred W. Fox, Oregon State College, Corvallis; Ralph P. Frazier, Emporia State Teachers College, Emporia, Kansas; George G. Mallinson, Western Michigan University, Kalamazoo; Edith M. Selberg, Colorado State College, Greeley; and William J. Walsh, Michigan State University, East Lansing.**

### First Appearance?

Let us consider some recent investigations dealing with the question of *when* this phenomenon first appears. Scannell (1) found that the best single predictor of success in college was academic performance in high school, although achievement test scores starting with the fourth grade can be used. Frankel (2) reported that underachievement among intelligent high school boys could be predicted from the junior high school record and that the factors which were related to underachievement may have been in operation before these students entered high school. Shaw and Grubb (3) in their study of gifted underachieving boys in high school hypothesized that underachievement was not a problem which had its origin within the classroom but rather one which the student brings with him, at least in embryo form, when he enters high school. Barrett (4) found patterns of underachievement apparent as far back as the fifth grade. Shaw and McCuen (5) found that academic underachievement among bright high school boys had its genesis in the first grade or elementary school. By the third grade the difference between achieving and underachieving boys became significant and continued to increase to grade 10. In grades 10 and 11, the difference decreased slightly but not significantly, due to a slight drop in the grades of the achievers.

Among underachieving high school girls, however, the pattern was strikingly different. For the first five grades of elementary school, Shaw and McCuen reported that the female underachievers exceeded the achievers in scholastic average. Beginning with the sixth grade, the underachievers began a precipitous drop in school average and remained below the achievers until the eleventh grade. The difference became significant at grade 9, and by grade 11 there was a slight decrease in the difference between the two groups because of a drop in the school average of the achievers.

In all these studies, it was found that

once the pattern of underachievement was established it generally persisted and tended to become worse as the youngster proceeded up the educational ladder.

It is significant that underachievement even at the college level has been traced back to the primary grades of elementary school. The fact that it has been found as early as the first grade seems to support the hypothesis that underachievement may originate in the home at preschool ages. It should not be inferred from these studies that all underachievers are found in the first grade. This situation emerges at all educational levels. The patterns of underachievement may have been initiated in the home before these children entered school. The factors which promote the expression of underachievement at any given level probably vary with the individual and with the circumstances surrounding the individual and the schools.

### Where Is Origin?

Evidence related to the onset of underachievement repeatedly leads to the home and the parents. There is nothing new or surprising in the fact that the child is a product of the home. What interests us, though, are the specific factors in the home which influence academic achievement and how these promote or discourage scholastic performance. The areas currently under study are the child-rearing practices and parental attitudes.

Winterbottom (6) found that mothers who train their sons at an early age for self-reliance and independence helped to create in them a desire to do well, whereas boys with a low drive for achievement had mothers who demanded less in the way of independent activities. Rosen and D'Andrade (7) studied child-rearing practices in boys: one was training to do things well (achievement training), and the other was training to do things without help (independence training). He discovered that a high motivation for achievement was related positively to these two practices. Thus, there seems to be a correlation between early achievement training in the home and the development of need for achievement in boys.

Pierce and Bowman (8), studying the motivational patterns in superior high school boys and girls with high and low achievement, also noted that the parents of high achieving boys placed early emphasis on responsibility and independent training. In all instances, moreover, they found that the high achievers demonstrated more responsibility and independence than their low achieving peers. They also found important variations in the development of educational motivations in girls as compared to boys, particularly in their relationships with their parents. Mothers of high achieving boys held democratic attitudes and encouraged verbalization in their children. Mothers of low achieving boys, on the other hand, were interfering and controlling. They fostered a dependence in their boys which tended to block achievement. Almost the reverse was true for girls. Mothers of high achieving girls were authoritarian, controlling, and strict, but they believed in equalitarianism.

Parental attitudes play a very important role in setting the aspirational level of academic achievement sought by their children. Shaw found that the parents of the achievers were more ego-involved not only in the education of their children, but in all their activities. Between the parents and children of the underachieving group a large emotional

gap which may be either neutral or negative in nature seems to exist.

### Implications

What are the implications of these studies for the schools? There is little doubt that underachievement exists in the primary grades of elementary school. Unfortunately, little is being done to identify or control it because of the lack of guidance and counseling at this level. The ability to help such youngsters at an early age before the patterns of underachievement are firmly established may prove to be less costly in time and effort later.

Parents exert a tremendous influence on the academic attitudes and aspirations of their children, and to overlook these key persons in any counseling process would be a grave error. They should somehow be made aware of the role they play in the genesis of underachievement as well as in providing their children with a drive for achievement.

The schools, too, should be re-examined to discover what factors tend to support underachievement in gifted students. Finally, the schools also have the responsibility of attempting to find solutions to these problems of scholastic underachievement.

### References


1. D. P. Scannell. "Prediction of College Success from Elementary and Secondary School Performance." *Journal of Educational Psychology*, 51:130. June 1960.
2. E. Frankel. "A Comparative Study of Achieving and Underachieving High School Boys of High Intellectual Ability." *Journal of Educational Research*, 53:172. January 1960.
3. M. C. Shaw and J. Grubb. "Hostility and Able High School Underachievers." *Journal of Counseling Psychology*, 5:263. Winter 1958.
4. H. O. Barrett. "An Intensive Study of 32 Gifted Children." *The Personnel and Guidance Journal*, 36:192. November 1957.
5. M. C. Shaw and J. T. McCuen. "The Onset of Academic Underachievement in Bright Children." *Journal of Educational Psychology*, 51:103. June 1960.
6. M. R. Winterbottom. "The Relationship of Childhood Training in Independence to Achievement Motivation." Unpublished Doctor's Thesis. University of Michigan. Ann Arbor, Michigan. 1953.
7. B. C. Rosen and R. D'Andrade. "The Psychosocial Origins of Achievement Motivation." *Sociometry*, 22:185. September 1959.
8. J. V. Pierce and P. H. Bowman. "Motivation Patterns of Superior High School Students." *The Gifted Student*. OE-35016. Monograph No. 2. U. S. Office of Education, Department of Health, Education, and Welfare. Order from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 1960. p. 33.
9. M. C. Shaw. *Attitude and Child Rearing Practices of Parents of Bright Academic Underachievers*. U. S. Public Health Service Research Project. No. M-2843. Order from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 1960.


**NOTE: The chairman, Dr. William B. Reiner, urges readers to submit their suggestions to him directly for future articles. The committee will make every effort to provide material for this column, but the participation and cooperation of each member are solicited as well.**

# Classroom IDEAS

## General Science

### Teaching the Metric System

By T. W. JEFFRIES, Kelso High School, Kelso, Washington

The metric system presents difficulties to the beginning student in science. Texts and teachers are partly to blame for this difficulty. Both usually tell the student that the metric system is based on a system of tens, but then they jump from the gram to the kilogram, the milliliter to the liter, and the centimeter to the meter without any of the intervening steps.

In an attempt to overcome this problem, the author has devised a modified number board (see photograph) essentially using the idea that the elementary teacher employs in teaching the number concept.

To start, the pupils develop the various place names of our ten-base number system and change a number to different names. For example, how many


tens does one represent? Development may then proceed to the various monetary units, such as mils, cents, dimes, and dollars. The students change one denomination to another.

Finally, the modified number board is introduced. The author has found this to be the most successful device available for teaching the metric system.

It will be noted that the infrequently used prefixes, deci-, deka-, and hecto-, are used to show the relation to ten and that the terms which are infrequently used are boxed to set them apart. The bottom of the board is folded over and stapled into compartments under each prefix.

To indicate numbers, slips of colored construction paper are inserted into the compartments. The numbers are placed on the blackboard and are converted from one unit to another in the same manner that the questions were placed to develop the number concept and location in the number session.

Students seem to grasp this relationship rapidly and with more ease and less drill than by simply memorizing.

## Earth Science

### Tornado Study

By PAUL STEVEN BAARSON, Horicon Junior High School, Horicon, Wisconsin

**This report was an entry in the 1960 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.**

Although it is usually difficult to construct classroom models for teaching weather, a small tornado can easily be built which demonstrates the conditions responsible for live tornadoes.

Tornadoes form at the bases of thunderstorms or cumulonimbus clouds where strong vertical updrafts are occurring. The rapid ascent of air in a tornado is due to the condition that the air near the ground is relatively warm and less dense than the air above.

We can create these conditions in the classroom when we heat a pan of water placed under a box with cardboard tubing on the top. (See Figure 1.) Slots in the corners of the box are arranged to permit cooler air from the room to enter the box and force the warmer air up through the tubing. The slots are cut so that all entering air will circulate counterclockwise, as it does in a tornado. Due to the mixing of the cooler air in the room and hot saturated air in the box, a cloud is formed in the center of the box which outlines the funnel cloud. The tubing may be replaced by a vacuum cleaner to produce a more severe tornado that actually will pick up small objects and water.

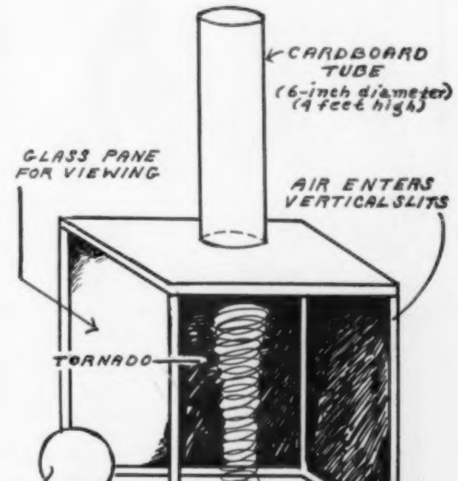



FIGURE 1.
Two sides are glass or plastic, one for light to enter and the other for viewing. The remaining two sides are painted black for contrast. The box is about 15 inches long on each side, and the vertical slots are about ¾ inches wide. The hole in the cardboard tube is about 6 inches in diameter. The tubing should be about 4 feet high. The light is projected in one side, and the funnel cloud is viewed against a dark background.

# Convention NOTES

## NINTH ANNUAL CONVENTION
## Chicago, Illinois
## March 24–29, 1961

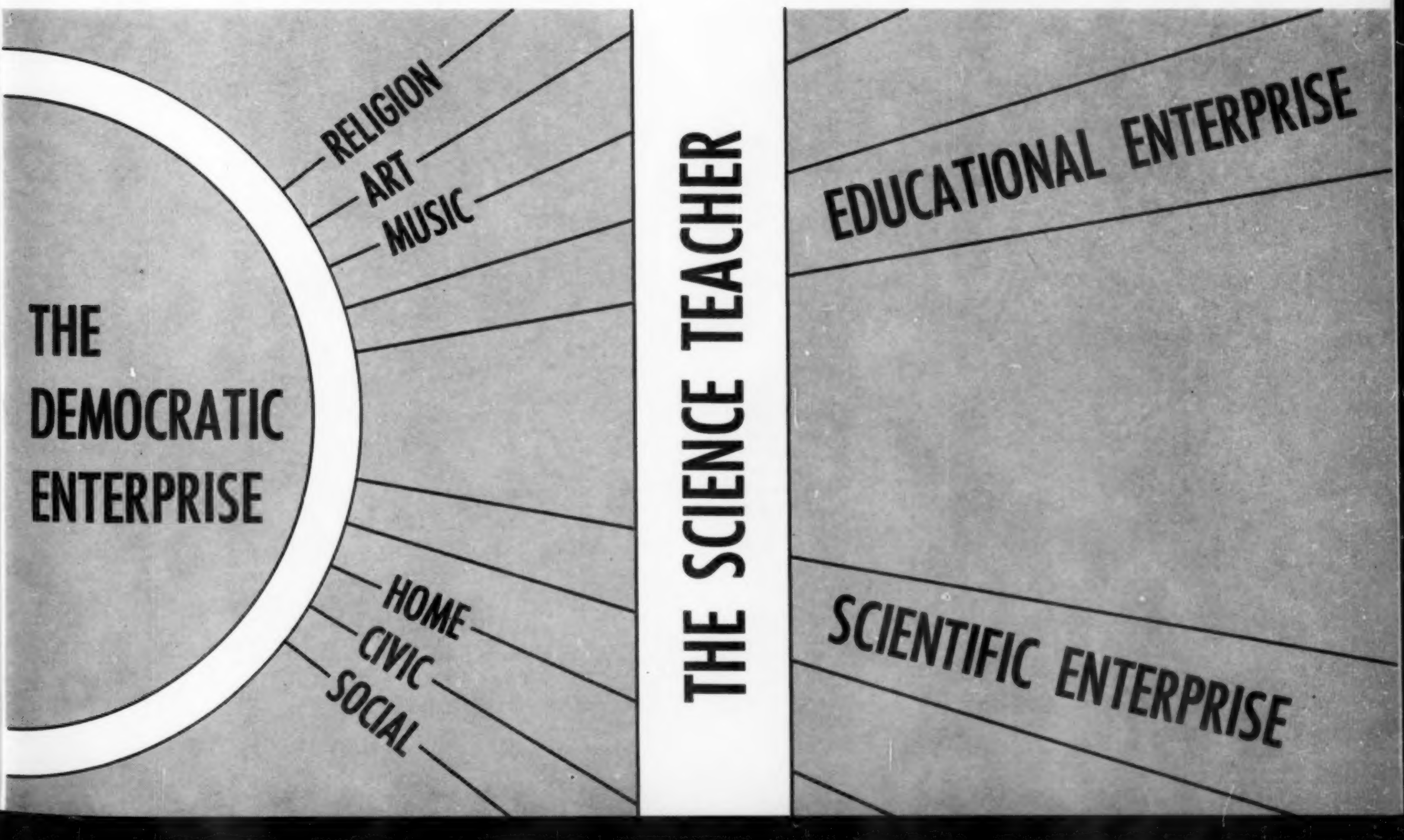
**THEME—"The Science Teacher: Seeking Excellence in an Age of Science."**

The goal of this year's convention relates to the teacher of science. How can the science teacher keep abreast of advances being made in even a small segment of those fields which provide basic instructional foundations for students? How can he best keep up to date on all of the national, state, and local problems now revolutionizing the content and method of science instruction? To help the teacher face these tasks realistically, as he strives for excellence in meeting the demands of our democratic, educational, and scientific enterprises, an important and comprehensive program has been planned.

The notable speakers featured on the following pages are scheduled for General Sessions throughout the week. The approach and keen insight which each will bring to our modern-day problems of education present an opportunity to develop new leadership in your professional undertakings. The subsequent panel sessions and follow-up discussions will enable you to define and correlate the most recent advances in your classroom activities. Tangible ideas of proven methods and procedures through the "Here's How I Do It" sessions will enliven your teaching.

For your benefit, the Annual Exposition of Science Teaching Materials of over 140 exhibits has been planned to bring you the most up-to-date information in these areas.

**Advance registration and reservation forms were inserted in the December issue of** The Science Teacher **to permit advance planning. If you have not mailed in your reservations, act now and keep current.**



# CHICAGO

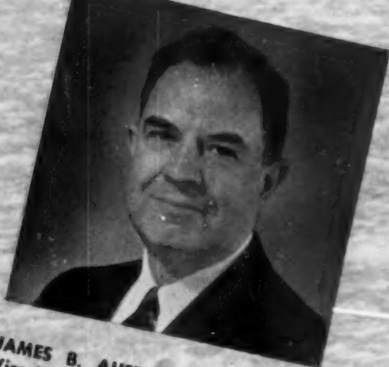
JAMES F. CROW. Chairman, Department of Medical Genetics, University of Wisconsin, Madison. Speaker, First General Session, Saturday morning. Title: "New Knowledge of the Gene."

HENRY EYRING. Dean of the Graduate School and Professor of Chemistry, University of Utah, Salt Lake City. Speaker, First General Session, Saturday morning. Subject: "Modern Trends in Chemistry."

PAUL E. KLOPSTEG. Chairman of the Board of Directors, American Association for the Advancement of Science, Washington, D. C. Speaker, Third General Session, Sunday afternoon. Subject: "How Science Advances."

JOSEPH J. SCHWAB. Professor of Natural Sciences and Education at the University of Chicago, Chicago, Illinois. Speaker, Fourth General Session, Sunday evening. Topic: "The Practical Teaching of Science as Enquiry."

GLENN O. BLOUGH. Professor of Education, University of Maryland, College Park. Address at elementary science luncheon, Monday. Title: "Excellence in Elementary Classroom Teaching."



JAMES B. AUSTIN. Administrative Vice President, Research and Technology, U. S. Steel Corporation, Pittsburgh. Speaker, Business-Industry-Education luncheon, Tuesday. Subject: "The Science of Science Teaching."

# MARCH 24-29

**HUGH ODISHAW.** Executive Director, U. S. National Committee for the International Geophysical Year, National Academy of Sciences-National Research Council, Washington, D. C. Speaker, Second General Session, Saturday evening. Topic: "International Cooperation in Science."

**ABRAHAM RASKIN.** Professor of Physiology and Coordinator of the Sciences, Hunter College, New York City. Speaker, Second General Session, Saturday evening. Report: "International Cooperation in Science."

**JAMES E. RUSSELL.** Secretary of the Educational Policies Commission, National Education Association and the American Association of School Administrators, Washington, D. C. Speaker, Sixth General Session, Tuesday morning. Subject: "The Central Purpose of American Education."

**GLENN T. SEABORG.** Professor of Chemistry, Associate Director of the Lawrence Radiation Laboratory, and Chancellor of the University of California, Berkeley. Co-winner of the 1951 Nobel Prize in Chemistry for his work of transuranium elements. Recently appointed as Chairman of the Atomic Energy Commission, Washington, D. C. Speaker, Annual Banquet (Fifth General Session), Monday evening. Title: "New Currents in Science Education."

**HERMAN SCHNEIDER.** Lecturer in Science Education, City College of New York, New York City, and well-known author of science books and textbooks for children. Speaker, Parallel Sessions, Sunday morning. Subject: "The Emerging Pattern of K-8 Science."

**R. WILL BURNETT.** Professor of Science Education, University of Illinois, Urbana. Address at Supervisors' Luncheon, Friday. Subject: "Science Teaching in the Middle East and East Africa." Speaker at Second General Session of the Association for the Education of Teachers in Science, Tuesday afternoon. Topic: "Improving the Doctoral Program in Science Education."

# AO Reports on Teaching with the Microscope

## Browsing in Sea Pastures . . . or a Study of Marine Diatoms

Every 19th century microscopist had his favorite test diatom slides. He would use them to check claims of microscope manufacturers for optical excellence. In 1848, Charles A. Spencer, our founder and America's first microscope builder, produced a microscope objective that resolved the skeletal lines of a Sigmoid Navicula . . . a test diatom that made all other test diatoms seem mere childs' play. So astounding was this feat that the diatom was renamed "Navicula Spencerii".

Understandably then, we are partial to any experiment concerning diatoms. Here is such a one. And we would like to remark that we still put the proud name, "Spencer", on every microscope we make, from the simplest student model to the most advanced research type. This name is your guarantee of top quality.

Anyone who has periodic access to *any* body of water can make comparative measurements of variety and kinds of diatoms to be found at various points. This could be done in both marine and fresh water areas, such as bays, ponds, estuaries, lakes, pools and similar environments.

### EXPERIMENT

**A Study of Marine Diatoms**

*By: Sister Jeanne Francis*
*Incarnate Word Academy*
*2930 South Alameda*
*Corpus Christie, Texas*

**MATERIALS AND PREPARATION:**

**A.** Remove the top and bottom from a wooden slide box. Place microscope slides in grooves and cover entire box with *wide mesh* hardware cloth. Hold in place with galvanized wire. Soak clothesline rope or sash cord in melted paraffin and affix it around the box with wire. Use enough rope so that box can be suspended in water from a pier.

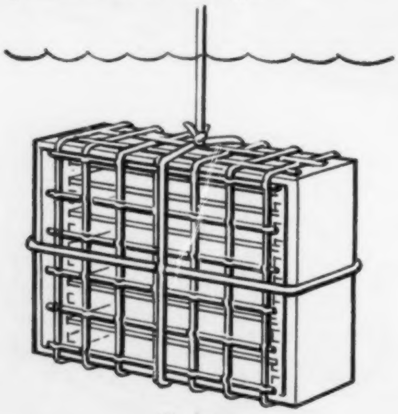


Fig. 1

**B.** Securing Diatoms

The diatometer should be suspended in the water so that it is free to swing with wave motion without bumping up against piles or pier supports. Site selected should have water deep enough to prevent bottom feeders from preying upon organisms deposited on the slides. Tidal variations common to the area must be taken into consideration for it is important that the box be kept in the photosynthetic zone as much as possible; roughly, within one foot is best unless water is unusually turbid, in which case, it should be somewhat less.

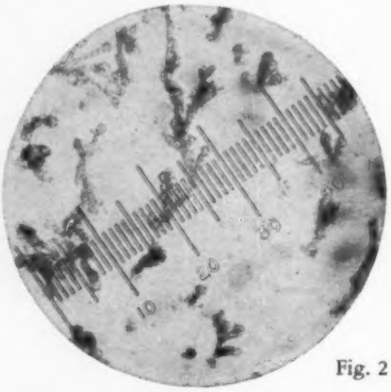


Fig. 2

Two week's submersion should be adequate. Even heavily contaminated waters will show results by this time, although there is likely to be little diversity of diatom species, and larger number of zooplankters may be present (See Fig. 2).

When taking the box back to the laboratory, keep it in a battery jar, or similar container, in water taken from the test site. Examine as soon as convenient since predators among the organisms may change the population pattern originally present.

**C.** Microscopic Examination

Remove rope and wire covering from the box. Select Petri dish with very flat bottom and place three drops of water, taken from test site, across the diameter. Using forceps or tweezers, transfer a slide from open diatometer to Petri dish, being careful to place slide on the line of water. If base underneath is not completely wet, add more water under the edge.

Then place three drops across the top of the slide and place three 22mm. square cover slips on the slide, thereby covering entire slide with cover slips (Fig. 3).

Fig. 3

Use Spencer AO #66 Student Microscope to observe slide (See Fig. 4). Remove high power objective and slide clamps to allow room for maneuvering Petri dish. Natural lighting, either daylight or a daylight-type microscope lamp, is best, since goldenbrown color of diatoms shows up clearest under daylight.

Low power observation is sufficient for surveying the field to observe diatoms present. Some protozoans may be present and all motile forms are quite active in freshly obtained specimens.

To make a quantitative survey, begin counting at top left of slide and work down, in rows, moving over a bit each time. Each cover slip area will yield five or more rows in a rough count; edges of the cover slips will serve as "landmarks". If a count is desired it will be necessary to differentiate between the forms present.

Fig. 4

**OBJECTIVES:**

To become acquainted with one of the principal resources of the "pasture of the sea"...marine diatoms, and coincidentally, with some of the other planktonic organisms found in the same environment. Also to familiarize the student with some of the investigative procedures and research techniques of the scientist.

The student scientist may wish to make investigations of conditions in his own area. Scientific publications on oceanography and limnology will give more detailed directions concerning techniques employed, gathering of data, interpreting results, and drawing valid conclusions.

**FREE BOOKLET!** **Hundreds of teachers have written asking for additional copies of our experiment ads. Because of this we have prepared a manual containing experiments published during the last 2 years. The booklet also covers terms used in microscopy and valuable information on use and normal maintenance of microscopes. Your copy is free and waiting for you. Just write Dept. P95 at the address below.**

**American Optical Company**

**Instrument Division • Buffalo 15, New York**


## NSTA Staff

A major new activity in NSTA's expanding program for 1960-61 will be the understaking of the "Vistas of Science" books to be published in cooperation with Scholastic Book Services, Inc. (See September 1960 *TST*.) As evidence of the importance and magnitude of this project, the Board of Directors has authorized a new professional staff position under which the work will be directed and coordinated. We are pleased to announce that Marjorie Gardner joined the NSTA staff in January to serve as Director of "Vistas of Science."

A native of Utah, Dr. Gardner did undergraduate work at Utah State University, and completed the MA and PhD degrees in science education at The Ohio State University. Formerly, she taught chemistry and journalism in the Richmond, Utah and Las Vegas, Nevada public schools. At The Ohio State University, Dr. Gardner served in a joint capacity in chemistry and science education. Her duties in the chemistry department were those of lecturer in general chemistry. Joining her to reside in the Nation's Capital are her husband Paul and their two children.

### Publications

Another area of growing importance includes the work in publications of NSTA. The route that our professional journal, *The Science Teacher,* must follow is clearly laid out. It requires that we keep in phase not only with advances in science, but also with changes pertaining to the application of new communication devices and techniques related to educational problems. Since the first issue of our journal, we have endeavored to cover the many areas of interest of our profession and report them promptly. Currently, our journal has achieved status representative of the recognition given to many of the leading technical publications issued by professional associations. Other publications issued by NSTA have been planned to give an extensive coverage and interpretation of the new trends in science education.

With the expansion of these activities and the additional new programs becoming a part of NSTA, the responsibilities of the Executive Secretary and the professional staff become broader. In recognition of these responsibilities, the NSTA Executive Committee has recommended two major changes which relate to the publications activities of the Association.

Effective January 1, your Editor for these many years, Robert H. Carleton, became **Editorial Director** of *The Science Teacher* and will serve also in this capacity in connection with all publications produced by the Association. The function of this office will be concerned with the broad over-all responsibility of direction, policy, management, and publications objectives.

Frances J. Laner, who has served as Associate Editor since 1958, has been promoted to the role of **Editor** of *The Science Teacher*.

In relation to the staff function of NSTA, Miss Laner serves also as Director of Publications and will assist in forming policy and directives on other publications and in advertising.

## Film Research Project

NSTA has accepted an invitation from the University of Illinois to cooperate in the production of films portraying classroom and laboratory activities in biology. Emphasis will be given to current needs, and areas will be selected to demonstrate improved methods for teaching scientific processes and modes of inquiry. Maximum effort is being made to develop film sequences which will introduce secondary classroom procedures and experiences of value to student viewers aspiring toward teaching careers.

## International Activities

An unexpected but challenging development has brought to NSTA a second major activity in the field of international relations. The endeavor became crystallized through cooperation with the British Science Masters' Association, the British Ministry of Education, and NSTA, supported financially by a grant from the National Science Foundation. A team of five delegates representative of elements in the NSTA program and of science teaching in the United States was chosen by NSTA to attend two important meetings of science educators in Glasgow, Scotland and London, England from January 1-17, 1961. First of these was the Sixtieth Annual Meeting of The Science Masters' Association at the University of Glasgow, January 3-6. A visit to the University of Edinburgh on Saturday, January 7, enabled the delegates to make other professional contacts and visits.

**Effective with this issue, the FSA ACTIVITIES will be combined and reported under this department head instead of separately as in the past.**

The NSTA group arrived in London on January 8 where for nearly a full week discussions were held involving science education officials and representatives of science teacher organizations from the United Kingdom and other European countries.

The venture essentially was an exploratory conference looking forward to possible establishment of more formal international cooperation among appropriate groups engaged in the many areas of our profession.

Delegates representing NSTA and the

The NSTA science education team poses before flight time: (l. to r.) Zachariah Subarsky, Fred R. Schlessinger, Ralph E. Keirstead, Abraham Raskin, and Robert H. Carleton.

# *You Can Depend on the* GENATRON

● ***The MODERN Electrostatic Generator***

THE CAMBOSCO GENATRON serves not only for classical experiments in static electricity, but also for new and dramatic demonstrations that are not performable by any other means. It exemplifies a modern method of building up the tremendously high voltages required for atomic fission, for nuclear research, and for radiation therapy.

Entirely self-exciting, the GENATRON cracks into action at the snap of the switch—whose only function is that of starting the motor drive. No auxiliary charging method is employed. Hence, despite an output measured in hundreds of thousands of volts, no hazard is involved, for the operator or for the observers.

### *An Output of 250,000 Volts—or More!*

THE CAMBOSCO GENATRON is designed to deliver, in normal operation, a discharge of the order of 250,000 volts. That figure, a conservative rating, is based on many trials conducted under average conditions. With ideal conditions, a potential difference of 400,000 volts has been achieved.

***Modern Design***— Sturdy construction and ever-dependable performance distinguish the GENATRON from all electrostatic devices hitherto available for demonstration work in Physics. This powerful, high-potential source, reflecting the benefits of extensive experience in electrostatic engineering, has absolutely nothing but purpose in common with the old-fashioned static machine!

**NO FRAGILE PARTS**—Durability was a prime consideration in the design of the GENATRON which with the exception of insulating members, is constructed entirely of metal.

The only part subject to deterioration is the charge-carrying belt, which is readily replacable.

**NO TRANSFER BODIES**—In all conventional influence machines, whether of Holtz or Wimshurst type, electrical charges are collected and conveyed (from rotating places to electrodes) by a system of "transfer bodies." Such bodies have always taken the form of metal brushes, rods, button disks or segments—each of which inevitably permits leakage of the very charge it is intended to carry, and thereby sharply limits the maximum output voltage.

It is a distinguishing difference of the GENATRON that electrical charges, conveyed by a non-metallic material, are established *directly upon the discharge terminal.* The attainable voltage accordingly depends only upon the geometry of that terminal and the dielectric strength of the medium by which it is surrounded.

### Unique Features of the CamboscO Genatron

**DISCHARGE TERMINAL** Charges accumulate on, and discharge takes place from, the outer surface of a polished metal "sphere"—or, more accurately, an oblate spheroid.

The upper hemisphere is flattened at the pole to afford a horizontal support for such static accessories as must be insulated from ground. A built-in jack, at the center of that horizontal area, accepts a standard banana plug. Connections may thus be made to accessories located at a distance from the GENATRON.

**CHARGE-CARRYING BELT** To the terminal, charges are conveyed by an endless band of pure, live latex—a CamboscO development which has none of the shortcomings inherent in a belt with an overlap joint.

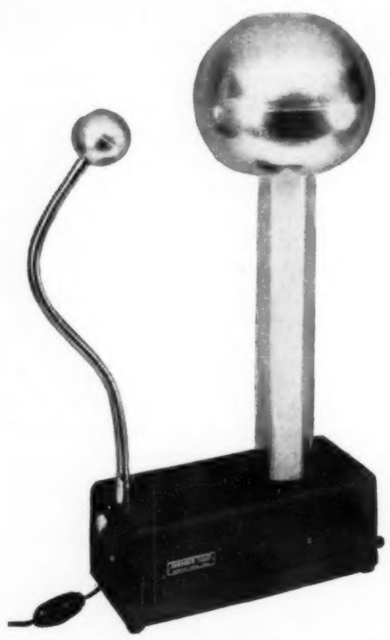
**DISCHARGE BALL** High voltage demonstrations often require a "spark gap" whose width can be varied without immobilizing either of the operator's hands.

That problem is ingeniously solved in the GENATRON, by mounting the discharge ball on a flexible shaft, which maintains any shape into which it is bent. Thus the discharge ball may be positioned at any desired distance (over a sixteen-inch range) from the discharge terminal.

**BASE...AND DRIVING MECHANISM** Stability is assured by the massive, cast metal base—where deep sockets are provided for the flexible shaft which carries the discharge ball, and for the lucite cylinder which supports, and insulates, the discharge terminal.

The flat, top surface of the base (electrically speaking), represents the ground plane. Actual connection to ground is made through a conveniently located Jack-in-Head Binding Post. The base of the Genatron encloses, and electrically shields, the entire driving mechanism.

**PRINCIPAL DIMENSIONS** The overall height of the GENATRON is 31 in. Diameters of Discharge Ball and Terminal are respectively, 3 in. and 10 in. The base measures 5¼ x 7 x 14 in.



**GENATRON, WITH MOTOR DRIVE**

Operates on 110-volt A.C. or 110-volt D.C.

Includes: Discharge Terminal, Lucite Insulating Cylinder, Latex Charge-Carrying Belt, Discharge Ball with Flexible Shaft, Accessory and Ground Jacks, Cast Metal Base with built-in Motor Drive, Connecting Cord, Plug, Switch, and Operating Instructions.

**No. 61-705 ....................................$98.75**

**GENATRON, WITH SPEED CONTROL**

Includes (in addition to equipment itemized under No. 61-705) built-in Rheostat, for demonstrations requiring less than maximum output.

**No. 61-708 ....................................$109.00**

**No. 61-710 Endless Belt.** Of pure latex. For replacement in No. 61-705 or No. 61-708. **$3.00**

## CAMBOSCO SCIENTIFIC COMPANY

**37 ANTWERP ST. • BRIGHTON STATION • BOSTON, MASS.**

science teaching profession were: Robert H. Carleton, Executive Secretary, NSTA; Ralph E. Keirstead, Consultant in Science, State Department of Education, Hartford Connecticut; Abraham Raskin, Associate Professor of Physiology and Coordinator of the Sciences, Hunter College, New York City; Fred R. Schlessinger, Associate Professor of Education, The Ohio State University, Columbus; and Zachariah Subarsky, Chairman, Biology Department, The Bronx High School of Science, New York City.

A report of these meetings, including recommendations resulting from the London Conference, will be published in a later issue of *TST*.

## Announcing . . .
## 1961 European Science Study Tour

The second international science study tour sponsored and conducted by NSTA has been scheduled for the period of approximately July 5 or 6 through August 16 or 17, 1961. As in the summer of 1960, thirty-two persons will be selected to represent the Association and the profession in conferences, special visits, and other science education activities now being arranged in England, Holland, West Germany, Austria, Switzerland, and France.

The study group will fly from New York City to London and then, after crossing to Holland, will tour the continental countries by chartered bus. Two features have been added to the 1961 study tour. First is a three-day side trip by air to Berlin. Second is a revised route through France to include the 15,000-year old cave paintings at Lascaux, the site where Cro-Magnon man's remains were found and the Cro-Magnon Museum. Repeat activities will include visits to the Shakespeare Theatre, the Salzburg Festival, the medieval walled city of Rothenberg, the Rhone Glacier, the Zuider Zee, and a Rhine River trip, among others.

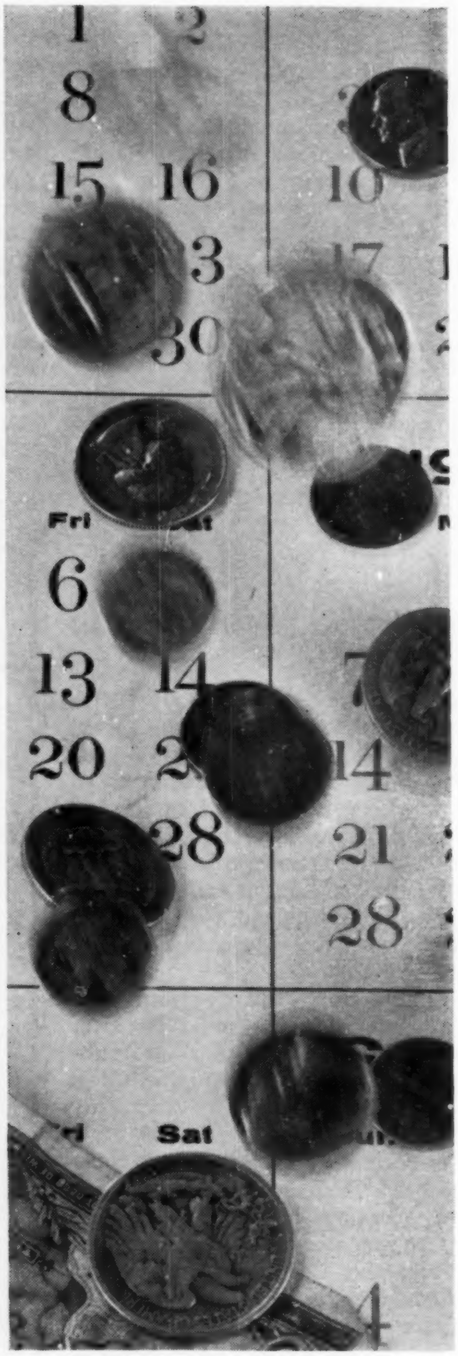
Over-all cost, except for certain meals in London and Paris, will be approximately $1350. Arrangements for the tour are being completed through the cooperation of the NEA Travel Division. Final schedule, itinerary, costs, and other detailed information will be available by March 1 and will be sent on request to all who are interested. It is not necessary to be a member of NSTA to be eligible for consideration.

## 1961 Convention

An innovation will be introduced by NSTA during the 1961 convention in Chicago. The American Gas Association plans to sponsor a closed-circuit television set-up to interview persons and outstanding teachers who have made contributions in science education, research, and related activities. The coverage will not extend to meetings or committee sessions held during the convention, nor will it interfere with time to visit the exhibits. Hugh Allen, Jr., Associate Professor of Physics and Science Education at Montclair State College, New Jersey, will serve as director. The cameras will be set up in an exhibit area in the Hotel Sherman. Come prepared; you too might be a TV star!

## Research and Development Committee

At the 1960 meeting, the Board of Directors authorized the establishment of a research and development committee, another important step forward. This committee will explore projects and initiate action for improvement or emphasis in the various areas of science teaching. The committee held its first meeting at NSTA headquarters on November 19, 1960. The programs proposed at this meeting are being referred to the Board of Directors for action. Members of



this committee are Zachariah Subarsky, *Chairman,* The Bronx High School of Science, New York City; Robert C. Stephenson, American Geological Institute, Washington, D. C.; Robert L. Silber, American Chemical Society, Washington, D. C.; Theodore Beck, El Cerrito High School, California; J. Arthur Campbell, Harvey Mudd College, Claremont, California; Dorothy Tryon, Redford High School, Detroit, Michigan; David Webster, Smith School, Lincoln, Massachusetts; Wayne Bland, Bell Junior High School, Tulsa, Oklahoma; and Rolland Gladieux, Kenmore Public Schools, New York.

## U. S. Registry

The 1961 U. S. Registry of Junior and Senior High School Science and Mathematics Teaching Personnel has just been completed. A total of approximately 141,000 teachers are presently listed on this registry.

The information for this list was obtained by writing to the various schools throughout the U.S. About 78 percent response has been received, representing some 30,347 schools. The list of names, broken down into the various science teaching disciplines, was updated as of February 1, 1961.

## FSA Organization

Recalling that the FSA school science club organization was activated less than six months ago, the goal of 1000 chapters set for the initial year of operation seems realistic. Nearly 600 chapters have been chartered to date, a rate of over 100 per month. Officers and staff of NSTA consider this to be solid approval of the policies and programs that have been established.

## Sponsor's Guidebook

Is there a science teacher who has not been plagued by students requesting suggestions for science projects? To provide assistance to FSA sponsors in meeting such demands, an annotated list of student science projects and ideas for projects is now nearing completion. The listing will include fifty projects each in biology, chemistry, physics, and general science. It is planned to include projects in mathematics, engineering, and earth science as the next step. The source of all the projects will be the reports made by students who won awards or honorable mention in past FSA awards programs. When completed, the material will be printed and distributed as a supplement to the *FSA Sponsor's Guidebook*. This, of course, will entail no additional cost to chartered chapters.

**Future Scientists of America Steering Committee**

Seated (l. to r.) Richard S. Smith, Haverford Township Senior High School, Havertown, Pennsylvania; William V. Brook, West Virginia Science Teachers Association, Huntington; Kenneth B. Hobbs, The Ohio Academy of Science, Columbus; Harry B. Packard, University of North Carolina, Chapel Hill; Anne E. Nesbit, South Junior High School, Pittsfield, Massachusetts; Olive W. Sudler, Millford Mill High School, Baltimore, Maryland; Joan Hunter, West Senior High School, Aurora, Illinois. Standing (l. to r.) William P. Ladson, (Staff) Director, FSA; Edward S. Beach, Jr., Chairman of the Committee, Prince Georges County Public Schools, Upper Marlboro, Maryland. Absent from the picture: Robert H. Horn, Waynesboro High School, Waynesboro, Virginia.

## FSA Steering Committee

In accord with the NSTA policy of keeping all programs and projects closely tied to "grass roots," a steering committee was named for the Future Scientists of America school science club program. (See October 1960 *TST*.) The committee will continually review and advise on the many aspects involved in the new youth organization and meet periodically to benefit from direct discussion among members. The first meeting took place on December 10, 1960, at NSTA headquarters in Washington, D. C. As a result, the steering committee's recommendations are being directed for consideration to NSTA Standing Committee No. 1 responsible for science education activities for youth. These suggestions include such items as producing an FSA informational filmstrip to assist sponsors in developing club programs, forwarding FSA materials to colleges for the information of prospective science teachers, and appointing an *ad hoc* committee to study the possibility of student invitational attendance at functions of scientific societies. The standing committee will evaluate the recommendations and present those considered significant to the NSTA Board of Directors.

The FSA Steering Committee invites critical evaluation concerning the FSA program and asks that any correspondence be sent directly to the committee chairman, Edward S. Beach, Jr., 1206 Burketon Road, Hyattsville, Maryland.

Continued evaluation of this program is welcome, but we encourage also the long-range planning suggestions for FSA.

## FSAA, 1961

The deadline is rapidly approaching for submission of reports of student projects to be entered in the 1960-61 Future Scientists of America Awards program. *All entries must be postmarked not later than midnight, March 1, 1961.* The program, now in its tenth consecutive year of operation, is open to all students in grades 7 through 12 enrolled in public and nonpublic schools in the United States and Canada. A feature of this FSA contest is the grouping of projects and awards into three categories: grades 7 and 8, 9 and 10, and 11 and 12. The awards consist of United States Savings Bonds, school plaques, and FSA certificates, with equal numbers of awards assigned to each of the three grade levels in each of eleven geographic regions. The total value of the awards this year is $10,000. Entry materials including rules, regulations, and student forms are still available from NSTA headquarters.

## Film Excerpt Committee

After a four-year period of suspended animation, NSTA's cooperation with Teaching Film Custodians (TFC) and the Motion Picture Association has been resumed under a committee headed by John G. Read of Boston University, Boston, Massachusetts. Work of this committee entails reviewing Hollywood pictures (or scripts) to identify portions amenable to excerpting, editing, and conversion into classroom films for teaching. Films produced by previous committees include *Yellow Jack, The First Atomic Pile, Expedition to Antarctica, Conquest of Pain,* and *Pioneer of Flight,* among others. Fields other than science in which teaching films are being produced through a similar pattern of cooperation are music, health, social studies, English, and family living. Rounding out NSTA's committee for 1960-61 are: Carolyn A. Gibson, North Hills High School, Pittsburgh, Pennsylvania; Jerome Metzner, The Bronx High School of Science, New York City; Clifford R. Nelson, Weeks Junior High School, Newton, Massachusetts; H. Craig Sipe, George Peabody College for Teachers, Nashville, Tennessee; and Ruth M. Stone, Coordinator of Science Instruction, Yonkers, New York.

Committee meetings are held in New York City with all expenses reimbursed by TFC.

## Motion Picture Research Project

As recently announced, the Association is actively engaged in a project to seek improved ways of portraying, by way of film, the activities and modes of inquiry employed by research scientists. In addition, consideration is being given to production of a series of junior high school



## NSTA CALENDAR

**As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST*'s calendar editor as early as possible.**

**February 22-25, 1961:** 34th Annual Meeting, National Association for Research in Science Teaching, Pick-Congress Hotel, Chicago, Illinois

**March 24-29, 1961:** NSTA Ninth Annual National Convention, Hotel Sherman, Chicago, Illinois

**July 7-9, 1961:** Annual Business Meeting of Board of Directors, NEA Building, Washington, D. C.

films. The research and the production of the films will be done at the University of Oklahoma, Norman, under the direction of Ned Hockman. The medical research scientists who will participate in the research, as well as appear in the films, are Leonard P. Eliel, Stewart G. Wolf, Jr., Henry N. Kirkman, and Alexander H. Woods. Also working on the project will be Henry Angelino, Professor of Educational Psychology at the University of Oklahoma. On December 9 and 10 the Advisory Board for this project met at NSTA headquarters to establish guidelines and policies to be followed throughout the project.

## OCDM Project

The NSTA civil defense education committee met at the University of California (Los Angeles) on January 13-14, 1961 to review the progress being made on the project which was reported in the September *TST*. The UCLA writing team presented the committee with the first draft of a book based on the criteria established by NSTA. This book is designed to teach those science concepts which are necessary to make students aware of the reasons for self-protection.

The book does not use the "scare" technique, which has been done in the past. Rather, it discusses the principles of such topics as nuclear radiation, radiation protection, climatic conditions, and other science-related topics that make up the framework of civil defense. As soon as this publication is completed, it will be made available to the NSTA membership.

## Elections, 1961

Twelve members of NSTA have been honored by this year's Elections Committee (see September 1960 *TST*) through their nomination as candidates for officers and directors of the Association for the ensuing year. The committee met and selected nominees in San Francisco, California on November 11-12.

As usual, all members of NSTA will receive ballots to enable them to vote by mail and help to choose Association leadership for the year ahead. Nominees for the various positions to be filled are as follows:

For President-elect:
- **Otis W. Allen,** Leflore County Schools, Greenwood, Mississippi
- **John H. Marean,** Reno High School, Reno, Nevada

For Finance Officer (formerly Treasurer):
- **Frederick R. Avis,** St. Mark's School, Southborough, Massachusetts
- **Alfred B. Butler,** Washington State University, Pullman, Washington

For Directors:

From Region I.
- **Elizabeth Ann Quinn,** Saxe Junior High School, New Canaan, Connecticut
- **Austin S. Kibbee,** Leavitt Institute, Turner, Maine

From Region III.
- **H. Craig Sipe,** George Peabody College for Teachers, Nashville, Tennessee
- **Margaret K. Noble,** Public Schools of the District of Columbia, Washington, D. C.

From Region V.
- **Virgil H. Heniser,** Thomas Carr Howe High School, Indianapolis, Indiana
- **Walter E. Hauswald,** Sycamore Community Schools, Sycamore, Illinois

From Region VII.
- **Dean A. Rosebery,** Northeast Missouri State Teachers College, Kirksville, Missouri
- **Rodney F. Mansfield,** Department of Education, Denver, Colorado

# BOOK Reviews

**The Book of Popular Science.** 10 volumes. $89.50, discounts to schools and libraries. The Grolier Society, Grolier Building, 575 Lexington Ave., New York 22, N. Y. 1960.

In a series of ten volumes, *The Book of Popular Science* covers fifteen broad subject areas devoted to all fields of science—the universe, the earth, life, plant life, animal life, man, health, matter and energy, industry, transportation, communication, science and society, household science, projects and experiments, and science through the ages. The many scientific topics are treated in a scheme of increasing complexity, and thus the publication can be used by students of varying degrees of ability. Many sections present the historical treatment of a subject as well as up-to-date information. Contributors represent persons of high caliber from all areas of science.

The publication must be viewed as a whole for an effective evaluation. Volume 10 contains the index for the complete set. A section on projects and experiments is helpful for teachers and students alike. The many excellent illustrations enhance the volumes' resource value.

*The Book of Popular Science* should be particularly helpful for teachers and students in schools and communities where science references are limited or practically nonexistent. The volumes are rich resources for special reports by students. This reviewer had a class of graduate students in science education examine the volumes. The consensus of this group was that the publication would be a valuable asset for junior and senior high school libraries.

BURTON E. VOSS
*Pennsylvania State University*
*University Park, Pennsylvania*

**Physics.** The Physical Science Study Committee of Educational Services Incorporated. 656p. $5.48. Laboratory manual with 52 experiments, $1.36. D. C. Heath and Company, 285 Columbus Ave., Boston 16, Mass. 1960.

From its beginning in 1956, the Physical Science Study Committee has aimed at producing a high school physics course offering an ordered progression of material from the simple to the sophisticated, culminating in the presentation of as much modern atomic physics as could be brought within reach of the high school student. The text, now in published form with a laboratory guide and associated materials, indicates an achievement of this end to an amazing degree. This represents more than just a textbook; the course is a new way of life for high school physics. It is not an easy text. The reading level is high, but not impossibly so. The problems are not stereotyped, and the weaker student will have difficulty. But, such a student faces the same difficulty in the traditional physics course.

The text is divided into four parts: The Universe (a broad overview), Optics and Waves, Mechanics, Electricity and Modern Physics. Omission of certain areas usually covered in the traditional text (for example, calorimetry) is more than compensated for by the thorough treatment of basic issues. The emphasis is on the understanding of fundamentals rather than on manipulation.

The use of color is sparing. Important formulas are not printed in color and emphasized by the use of stick figures pointing to them. Chapter summaries are held to a minimum. On the other hand, the best features of the preliminary editions have been retained, including most of the excellent original photographs and diagrams and the "home, desk, and laboratory problems" sections. The accompanying laboratory guide has abandoned the frequently seen "cookbook" format. The suggested experiments are imaginative and provocative. It is a guide in the true sense of the word.

MATTHEW H. BRUCE, JR.
*The DuBois Area Senior High School*
*DuBois, Pennsylvania*

# SCIENCE TEACHING MATERIALS

**Prepared by NSTA Teaching Materials Review Committee**

**Chairman: Dr. H. Seymour Fowler**

**The Pennsylvania State University, University Park, Pennsylvania**

## BOOK BRIEFS

**A Guided Tour Through Space and Time.** Eva Fenyo. 82p. $3.50. Prentice-Hall, Inc., Englewood Cliffs, N. J. 1959.

An informative book on relativity and other aspects of the physical universe. Suitable for advanced high school students. Includes a good glossary.

**Aviation in the Modern World.** James V. Bernardo. 352p. $5.95. E. P. Dutton and Company, Inc., 300 Fourth Ave., New York 10, N. Y. 1960.

This book performs a triple role. One section of the publication is devoted to the use of the airplane in the modern world. Another discusses space and its exploration, and a third section treats of careers and opportunities in aviation. An appendix with lists of materials for air-age education is included. Because of its organization and wealth of material the book would be useful in junior and senior high schools.

**Guide to the Space Age.** C. W. and Hazel C. Besserer. 320p. $7.95. Prentice-Hall, Inc., Englewood Cliffs, N. J. 1959.

A complete guide to space-age terminology. Ranges from space technology in general to rocketry and missiles. Some examples of space-age slang are also included. An excellent resource book for teachers and students.

**From Submarines to Satellites, Science in Our Armed Forces.** Margaret Hyde. 106p. $3.50. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y. 1960.

An up-to-date account of science and technology in our armed forces. Includes information on such topics as missiles and satellites, anti-submarine defense, air defense, and ballistic missile warning systems. Good reading for those who expect to serve in the armed forces and those interested in modern developments in the military field. Illustrated with photographs.

**Planet Trips.** William Nephew and Michael Chester. 72p. $2.75. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1960.

A vivid and authoritative story about the men, space platforms, and space ships that may some day be involved in the first trip to the planet Mars. Realistically told by the authors, who are missile research men. Designed for ages 8-12 but has adult appeal also. Attractively illustrated.

**Medicine Today. A Report on a Decade of Progress.** Marguerite Clark. 352p. $4.95. Funk and Wagnalls Company, 153 East 24th St., New York 10, N. Y. 1960.

Many of the startling and important developments reported in this up-to-the-minute documentary survey of the medical advances of the last decade have been written for the vast public that is vitally interested in medicine. This report, derived from personal interviews with the best-known practitioners and researchers in the country today, is presented so that the layman can understand the whole dramatic picture of medical progress. The report discusses the newest techniques in surgery, radiation, and drugs that may halt the great killers—heart disease and cancer. Also included is recent information on the prevention and treatment of the so-called "nuisance diseases" such as the common cold, tooth decay, acne, and ulcers. Other topics cover techniques for helping the millions of adults and children who suffer from mental illness, progress in the treatment of alcoholism, the medical problem of the aged, the story of how drugs are produced, and hospital conditions. Especially recommended for biology, chemistry, and health classes but should also prove interesting to all high school students.

**101 Science Experiments.** Illa Podendorf. 158p. $4.50. Children's Press, Inc., Jackson Blvd. and Racine Ave., Chicago 7, Ill. 1960.

A beautifully illustrated volume of simple experiments covering such topics as air, magnets, electricity, water, sound, light, simple machines, heat, chemistry, and plants. Most of the experiments may be completed with simple equipment. Some are standard. Many are commonplace activities which have been interpreted in the form of new experiments. Others introduce a control situation. Would be useful in the hands of young scientists in grades 4 to 7, initiating them to some of the interesting, yet simple, experiments of science. The book is a storehouse of information for the elementary school teacher.

**Elementary Teachers Guide to Free Curriculum Materials.** Edited by Patricia H. Suttles. 366p. $7.50. Educators Progress Service, Randolph, Wis. 1960.

This Seventeenth Annual Edition of the guide contains many titles for use by elementary and junior high school teachers. As in its companion volumes, there are three divisions: Title, Subject, and Source Index. At least three of the resource units which are included would be useful to elementary school science teachers.

**The New Mathematics.** Irving Adler. 192p. 50¢. A Mentor Book, The New American Library of World Literature, P. O. Box 2310, Grand Central Station, New York 17, N. Y. 1959.

Although addressed to the lay reader, this book would be valuable for the library of every science and mathematics teacher. The author introduces the new mathematical concepts which have had considerable publicity since the launching of Sputnik. The manner in which Adler writes makes it possible for anyone with high school algebra and plane geometry to understand the book, enjoy it, and work on many of the "do it yourself" examples at the end of the chapters. At the paperback price of 50 cents, many a high school mathematics teacher can encourage his students to buy the little volume for "enrichment" class work. It is highly recommended by the School Mathematics Study Group at Yale University for this purpose.

**The Watershed—A Biography of Johannes Kepler.** Arthur Koestler. 280p. 95¢. Doubleday Anchor Books. Order from Wesleyan University Press, Inc., Columbus 16, Ohio. 1960.

*The Watershed* is a study of a genius and gives an insight into the scientific thinking of Kepler's time. Kepler bridged the gap between ancient and medieval thought and modern observational science and in this way made an outstanding contribution to man's changing vision of the universe. This volume is one of the Science Study Series prepared under the direction of the Physical Science Study Committee of Educational Services Incorporated. Designed for advanced high school students.

**The Oscillating Universe.** Ernest J. Opik. 144p. 50¢. The American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. 1960.

This is a fascinating collection of short essays on astronomy for the uninitiated. The subjects discussed range from the origin of the earth, the moon, sun, and brother planets to the expanding universe and its origin and fate. The entire book can be

read with continuity or as individual essays independent of other chapters.

**Educators Guide to Free Films.** Compiled and edited by M. F. Horkheimer and John W. Diffor. 640p. $9. Educators Progress Service, Randolph, Wis. 1960.
The nineteenth edition lists 4276 titles of free films including 591 new annotations which have not appeared in previous editions. Three indexes—title, source, and subject—permit easy reference. Recommended for every high school audio-visual department.

**The Opaque Projector.** Kenneth L. Bowers. 42p. $2. Visual Instruction Bureau, The University of Texas, Austin 12, Texas. 1960.
This is an excellent book which offers a considerable number of ideas for the use of the opaque projector. The sections on preparation of materials for opaque projection and specialized techniques offer some unique suggestions that would be useful to science teachers at all levels.

**Michelson and the Speed of Light.** Bernard Jaffe. 198p. 95¢. Doubleday and Company, Inc., Garden City, N. Y. Available to secondary students and teachers through Wesleyan University Press, Inc., Columbus 16, Ohio. 1960.
This paperback provides a rich supplement to the study of light and optics. The content traces the life of Albert Michelson and describes his work in experimental physics. Vivid explanations of Michelson's work with the interferometer, diffraction grating, and spectroscope are given. The Michelson-Morley drift experiment to refine measurements on the speed of light receives much emphasis. The work would have appeal for high school students because it provides an image of a great scientist as well as rich supplemental material.

**Exploring the Air Ocean.** Frank Forrester. 70p. $2.75. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1960.
Presents basic facts that should satisfy the curiosity of the young student concerning weather phenomena. The vivid illustrations bring to life many interesting experiments and discoveries of scientists who have devoted their lives to interpreting the weather. A visit to a modern weather station to see the latest instruments meteorologists have devised to forecast the elements is described. The reader also discovers how man may be able to control the weather in the future. Recommended for the elementary grades.

**The Electronic Guide.** Edited by David Early. 192p. $7.50. References for Research Division, Electronic Guide Publishing Company, 4131 Toluca Lake Ave., Burbank, Calif. 1960.
This index of more than 4000 articles in the field of electronics will be of interest to amateurs, technicians, experimenters, and engineers. The titles have been extracted from popular magazines as well as highly technical journals published in the United States and six other English-speaking nations. The bibliography at the end of the *Guide* includes addresses and subscription prices of the publications.

**Scientists Who Changed the World.** Lynn and Gray Poole. 156p. $3. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1960.
The authors have chosen to describe the work of seventeen scientists whose thinking was creative and original and who opened up new frontiers in science. Among the candidates selected are Copernicus, Galen, Darwin, Pasteur, and Freud. These men, among others, affected the total structure of scientific and human development. This book should prove interesting supplementary reading for high school students and would be a worthy addition to any school library.

## PROFESSIONAL READING

**"Communist Chinese Claims Regarding Scientific Progress in the Last Decade."** *Science News Letter*, 24:377. December 10, 1960. Under a special grant from the National Science Foundation, the publishers present an unedited document which first appeared in *Scientia Sinica*, a Communist Chinese periodical. The reader is introduced to Communist Chinese scientific philosophy, claims to progress and achievement, as well as shortcomings which they have acknowledged. A five-page bibliography is also included.

**"Studies in Teacher Education."** Science Teaching Improvement Program, American Association for the Advancement of Science, 1515 Massachusetts Ave., N. W., Washington 25, D. C. March 1960. Contains descriptions of the experimental studies conducted in the colleges and universities participating in the teacher education program. Each of the cooperating institutions reports on a particular phase of its program.

**"Study on the Use of Special Teachers of Science and Mathematics in Grades Five and Six."** Science Teaching Improvement Program, American Association for the Advancement of Science, 1515 Massachusetts Ave., N. W., Washington 25, D. C. 1960. The purpose of the study was to ". . . assess the possibility of the special-teacher kind of organization as an effective way of teaching mathematics and science and yet not place such emphasis on these two areas of knowledge as to weaken the elementary school as a whole." The report covers the general findings in each of the participating cities.

**"Determining an Empirical Formula."** *Journal of Chemical Education*, 37:5161. October 1960. Explanation and experiment of a simple, rapid procedure for establishing the empirical formula of a compound. The method is inexpensive and could be made operative in any existing high school laboratory. Although the article will be most valuable to chemistry teachers, there are possibilities for using the procedure in all science classes.

## AUDIO-VISUAL AIDS

**Living with the Atom.** Presents the birth of atomic theory by Albert Einstein. Other features depict the amount of energy released from an atom of a substance, an electrolysis demonstration to show that water is composed of hydrogen and oxygen atoms, a model of an atomic structure, and a demonstration of the Brownian movement. Atmospheric pressure is demonstrated by crushing a can. The film explains the difference between chemical energy and nuclear energy, shows atom smashers, describes the chain reaction, and pictures atom and hydrogen bomb tests. The moral obligation to control nuclear tests is presented. For grades 8-12. 27 min. Color $220. 1960. Moody Institute of Science, 11428 Santa Monica Blvd., Los Angeles 25, Calif.

**Water in the Weather.** An elementary science film which treats the relationship between weather and the sun, the atmosphere, land areas, and water areas. Illustrates with animation the blanket effect of the atmosphere. An interesting sequence using animation and actual photography shows the effect of dark-colored areas and light-colored areas on absorption. Simple laboratory experiments demonstrate how air is heated.

The effects of the amount of water in the air, its evaporation, and later return to earth's surface as precipitation are well depicted. Time-lapse photography shows cloud forms and their relationship to weather. The importance of the water cycle is stressed. Recommended for elementary science classes, grades 4-7. 16½ min. Color $165, B&W $90. 1960. Academic Films, 800 North Seward St., Hollywood 38, Calif.

**How Electricity Is Produced.** Film develops at an elementary level the method for producing static electricity and shows how electricity is formed by conversion of heat, light, and chemical energy. Demonstrates the operation of a hand generator and a large-type generator. Faraday's discovery of the relationship of magnetism and electricity is pictured. The film also suggests simple electrical experiments. Recommended for science in intermediate grades. 11 min. Color $110. 1960. Pat Dowling Pictures, 1056 South Robertson Blvd., Los Angeles 35, Calif.

**Principles of Nuclear Fission.** One of the films in the Advanced Science Series produced in Great Britain by the Educational Foundation for Visual Aids. Historic and modern conceptions of the structure of the atom are well presented. The fundamental particles—electron, proton, and neutron—are illustrated diagrammatically. Film describes in detail how bombarding neutrons produce fission in U 235. Critical mass is explained simply. Diagrams and photography are used to illustrate production of energy and controls in a nuclear reactor. Recommended for advanced high school and freshman college physics classes. 10 min. Color $125. 1960. Text-Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y.

**About the Human Body.** This is one of the films correlated with the Heath Elementary Science texts by Herman and Nina Schneider. Film opens by showing a boy visiting a doctor's office for a physical examination. Animation is used to demonstrate function of bones, muscles, and ligaments. The organs of the nervous, respiratory, digestive, and circulatory systems and their functions are portrayed. Because the film contains a wide range of topics given in rapid sequence, it might be useful as a review of health measures. The message is addressed to youngsters who either do not understand the importance of health examinations or who possess unwarranted fears about them. Recommended for grades 5-8 and for science and health classes. 15 min. Color $165, B&W $90. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

**Rocks for Beginners.** This elementary film covers an introduction to the identification of rocks. Topics include: formation of the earth's crust, lava intrusions, volcanoes, deposition of sedimentary materials, marine origins of limestone, folding, faulting, and the formation of metamorphic rock. Pictures formation of rock crystals by rapid and slow cooling, and includes useful clues to the identification of igneous, sedimentary, and metamorphic rock. The limited number of samples of each kind of rock, however, may pose problems in local areas. The film leaves viewer with the impression that rock identification is simple, but offsets this with an explanation that as the student progresses in rock collecting he will encounter the need for much more information. Recommended for elementary science classes in grades 4-6 and would also be useful for information before a rock-collecting trip. Color $165. 1960. Johnson Hunt Productions, Film Center, La Canada, Calif.

**Glaciers.** The film points out the geographical locations of glaciers and presents excellent action scenes of their formation and movement. Diagrams and film sequences illustrate the effects of glaciation which include such structures as valleys, lakes, canals, eskers, and the formation of the land bridge between Asia and North America. Maps show the paths which the ice sheets followed during the ice age, and the film indicates that another ice age could occur if the world temperature dropped to an average of only 10° Fahrenheit. Recommended for grades 7-12. 14 min. Color $120. 1960. Northern Films, Box 98, Main Office Station, Seattle 11, Wash.

**Wind at Work.** Earth's surface and our lives are changed by wind. Film shows wind at work in examples such as flying kites, a bird in flight, and an airplane in motion. Simple experiments illustrate that air is real, that it expands and contracts. A further example shows a child riding a bicycle on tires filled with air. An elementary understanding of wind motion as a result of unequal heating of the earth's surface is demonstrated by animation. Recommended for science classes, grades 5-8. 11 min. Color $110. 1960. Pat Dowling Pictures, 1056 South Robertson Blvd., Los Angeles 35, Calif.

**Chemistry Can Be Fun.** Two bingo games, Formo and Chemo, can be used by the teacher to enliven a drill period or as a novel review session. Each game contains directions, fact slips, a teacher's card, and 35 students' cards. Formo covers 100 inorganic chemical formulas. Chemo has 75 definitions of the chemical terms and processes usually emphasized in high school chemistry. The crossword puzzles contain definitions, properties, and processes of topics from gaseous elements to nuclear reactions. This collection of game materials would be useful for the teacher who insists on having the students memorize formulas and definitions of chemical terms and processes. The materials are also recommended as an occupation for the advanced students. Two games and 18 crossword puzzles. By Sister Mary Francesca, M.S.C. $2.50. 1959. J. Weston Walch, Publisher, Box 1075, Portland, Maine.

**We Get Food from Plants and Animals.** This film for primary grades clearly explains the sources from which food is obtained. The subject is dramatized by a scene in a grocery store showing two boys and a shopkeeper arguing about foods and their sources. Roots, stems, leaves, seeds, buds, and fruit are presented as edible parts of plants. Shown also are meat and dairy products and the animals from which they are derived. Discussed is the dependence of animals upon plant life. Film concludes with a brief treatment of imported foods such as bananas and pineapples. For primary grades. 11 min. Color $130, B&W $65. 1960. Text-Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y.

**The Sun's Energy.** Film answers many questions concerning this topic. Illustrated is the relationship of the sun's energy to the wind, the photosynthetic process and production of food for animals, algae culture, the water cycle, and the conversion of forms of energy. Film also includes an objective coverage of the sun's use in a solar engine, solar still, solar furnace, and solar boiler. Recommended for science classes, grades 6-9. 16½ min. Color $165, B&W $90. 1960. Academy Films, 800 North Seward St., Hollywood 38, Calif.

**Learning to Look.** A set of six filmstrips, a 33⅓ rpm record, and a guide containing frame titles and instructions. Titles of filmstrips are: *Trees, Lumber, Plants, Flowers, Textures,* and *Soil, Sand and Stone.* The record has three sound tracks on each side and is designed to provide a commentary and musical background for the filmstrip. As a test of observation, the commentary and the filmstrip point out shapes, forms, designs, colors, and shading. Film may be useful as supplementary material for biology classes since objects of science are used. It may help also to point out many features in nature that the average observer never sees. Set $36.50. 1960. Filmscope, Inc., Box 397, Sierra Madre, Calif.

**Copper, Steward of the Nation.** Depicts through photography and animation the production of copper and its importance to the southwestern United States and to the nation. The film dramatizes early prospecting, mining camps and towns, and development of industry. Describes the history of underground mining and the use of open-pit mines for low-grade ores. Production of copper is explained from its extraction through crushing, grinding, and flotation. We are then shown the process of smelting, conversion, casting, fire refining, casting of anodes, and the final refining by electrolysis. Lists variety of uses of copper, especially in electrical industry. For upper elementary, junior high, senior high, and college classes. 12 min. Color $120, B&W $60. 1960. Avalon Dagget Productions, 441 North Orange Drive, Los Angeles 36, Calif.

# APPARATUS & EQUIPMENT

**Science Kit.** A portable science laboratory which contains over 80 pieces of apparatus, a good Teacher's Manual of Experiments, a Manual of Astronomy, and a Star Chart. It is packaged in an attractive wooden box with a secure top and two handles. In these days of increasing emphasis on demonstrations and laboratory exercises, this kit would be especially useful as a teaching aid in junior high school and in the self-contained classroom, grades 4-6. One of the criticisms leveled at kits in general is that they reduce individual teacher initiative. This reviewer would prefer to think that kits are a basic necessity for the self-contained classroom. They can and should be supplemented by the teacher. $39.95. Science Kit, Inc., Box 69, Tonawanda, N. Y.

**Magnets and Coils Kit.** A compact arrangement of materials for teaching magnetism, particularly electromagnetism. Contains six Alnico magnets, four coils, three erection bases, tool steel, six pieces of iron, battery and leads, a magnetic wand, magnet wire, four compasses, iron filings, and support bars. A complete set of instructions is enclosed, with directions for completing ten different experiments. A discussion of the nature of magnetism is also included. Would be useful for small group projects in elementary science classes, grades 5-8. $19.95. Science Education Division, Product Design Company, 2796 Middlefield Rd., Redwood City, Calif.

**Elemento.** This kit provides junior high school students with an introduction to chemistry. Includes wall chart of the Periodic Table of the Elements, an illustrated manual, and a card game of the chemical elements. Each card in the game describes one element including atomic number, atomic weight, characteristics, valence, isotopes, and chemical group to which the element belongs. The illustrated manual explains the suggested game and includes factual information covering the periodic table, structure of the atom, the element groups, isotopes, and atomic energy. Use of attractively packaged equipment should add hours of enjoyment to the learning process in chemistry. Recommended for junior high science classes. Would be a useful teaching aid in chemistry if the learning nature of the kit were emphasized. $3.95. Science Materials Center, 59 Fourth Ave., New York 3, N. Y.

**Science Kit Junior.** This should be a welcome addition to the classroom of the elementary school teacher from kindergarten through grade 3. It contains a variety of equipment from annunciator wire to tuning forks. Includes some 31 different items, many of which occur in quantity. The accompanying laboratory manual lists and describes some 13 different experiments. A list of inexpensive replacement parts is also included. The kit is packaged in a sturdy cardboard container which is not too heavy for children to carry. With today's emphasis on more and better elementary school science, this miniature laboratory should prove very useful. $21.75. Science Kit, Inc., Box 69, Tonawanda, N. Y.

**The Dynamics Kit, No. 800.** As part of the Physical Science Study Committee equipment, this kit consists of two identical three-wheel carts capable of carrying loads up to ten kilograms. The carts have low-friction, ball-bearing wheels; space for carrying up to five ordinary building bricks as test masses; and rubber bands for towing along a smooth surface under constant force. The kit is useful in experiments with velocity, acceleration, momentum, and energy. No difficulty is encountered in the assembly which can be accomplished in a few minutes. For collision studies involving momentum and interaction, the carts are equipped with spring-loaded thrust rods which may be easily cocked and triggered. These spring-loaded bumpers are a great improvement over the hack-saw blade bumpers employed in some other models. By way of further improvement, one change is suggested. A metal rod might be substituted for the wooden dowel used to trigger the thrust rod. $5.70. Macalaster Bicknell Company, 253 Norfolk St., Cambridge 39, Mass.

# N·S·T·A LIFE MEMBERS

The increased number of science teachers who join our organization as life members continues to contribute significant support to the growth of our Association. Our Life Member roster with the addition of 64 science teachers rose to a total of 551 in 1960. The entire NSTA membership reached an all-time high of about 16,000 individual members. The goal for 1961 is 18,000 members.

Life membership is $150 if paid within three years, or $175 if paid in 10 annual installments. Direct your inquiries regarding life membership to our Membership Secretary.

Following are the year's 64 new Life Members:

Amato, Gerlanda V., Pemberton, West Virginia
Axelson, Donald R., Chicago, Illinois
Bacon, Francis F., Philadelphia, Pennsylvania
Beuoy, William E., Muncie, Indiana
Burrow, George I., Port Byron, Illinois
Campbell, Ethel S., Charleston, South Carolina
Comer, Michael Thomas, Corvallis, Oregon
Crawley, Harold B. Jr., Fairfield, Iowa
Cross, Richard Orrin, Belmont, California
Day, Gary, Green River, Wyoming
Dorn, Robert A., Chicago, Illinois
Farrel, Robert F., Steelville, Missouri
Feighner, Lena Veta, Kansas City, Kansas
Frank, Morton E., Deer Park, New York
Green, William H., Vancouver, Washington
Hall, Edward L., Scappoose, Oregon
Hastings, Andrew S., Los Gatos, California
Haugerud, Albert, Seattle, Washington
Heck, Joseph L., Oxnard, California
Hedbavny, Leopold, Jr., Brooklyn, New York
Herzer, Harry B., III, Effingham, Kansas
Hubbs, Earl L., Huntington Beach, California
Huggler, Richard J., Rochester, New York
Hutchinson, John S., Milwaukee, Oregon
Johnson, Ulric Q., Grand Forks, North Dakota
Kitzmiller, Robert B., Dade City, Florida
Ledbetter, W. M. (Mrs.), Skellytown, Texas
Lightner, Jerry P., Great Falls, Montana
Lisonbee, Lorenzo K., Mesa, Arizona
Luck, Edna, North Miami, Florida
McInerney, Paul J., Union City, Pennsylvania
Moore, Edward W., Gary, Indiana
Morano, Michael, Stronghurst, Illinois
Nunes, Joseph P., Winchester, Massachusetts
Pack, Richard, Glendale, California
Pile, Mildred H., Louisville, Kentucky
Quenemoen, Robert L., Great Falls, Montana
Reynolds, G. William, Jr., Latham, New York
Rockman, John N., Wayne, New Jersey
Rowan, Tom, Live Oak, Florida
Schlessinger, Fred R., Columbus, Ohio
Schneider, Herman, New York, New York
Schwartz, John D., Niagara Falls, New York
Shear, Blanche, Brownwood, Texas
Shober, Glenn G., Denver, Colorado
Sister M. Hermias Mennemeyer, S.S.N.D., Washington, Missouri
Smith, Deryle, Emporia, Kansas
Snow, David R., Delaware City, Delaware
Snowden, Commora B., Charlottesville, Virginia
Spera, Agnes E., Mount Ayr, Iowa
Starr, William, Euclid, Ohio
Steele, Duane C., Pontiac, Michigan
Strong, Delee, Garfield, Washington
Sutherlin, E. Thomas, Brown Summit, North Carolina
Tannenbaum, Harold E., New Paltz, New York
Trybalski, Edith, Ithaca, New York
Vorvick, Norman D., Othello, Washington
West, Floyd R., Galion, Ohio
Westerman, Howard W., Belton, Missouri
Williams, George I., Maryville, Missouri
Williamson, Stanley E., Corvallis, Oregon
Wood, Donald A., Wayne, Pennsylvania
Woodrow, Robert L., Jr., Rockville Centre, New York
Wright, Peter Burum, Jr., Bartow, Florida

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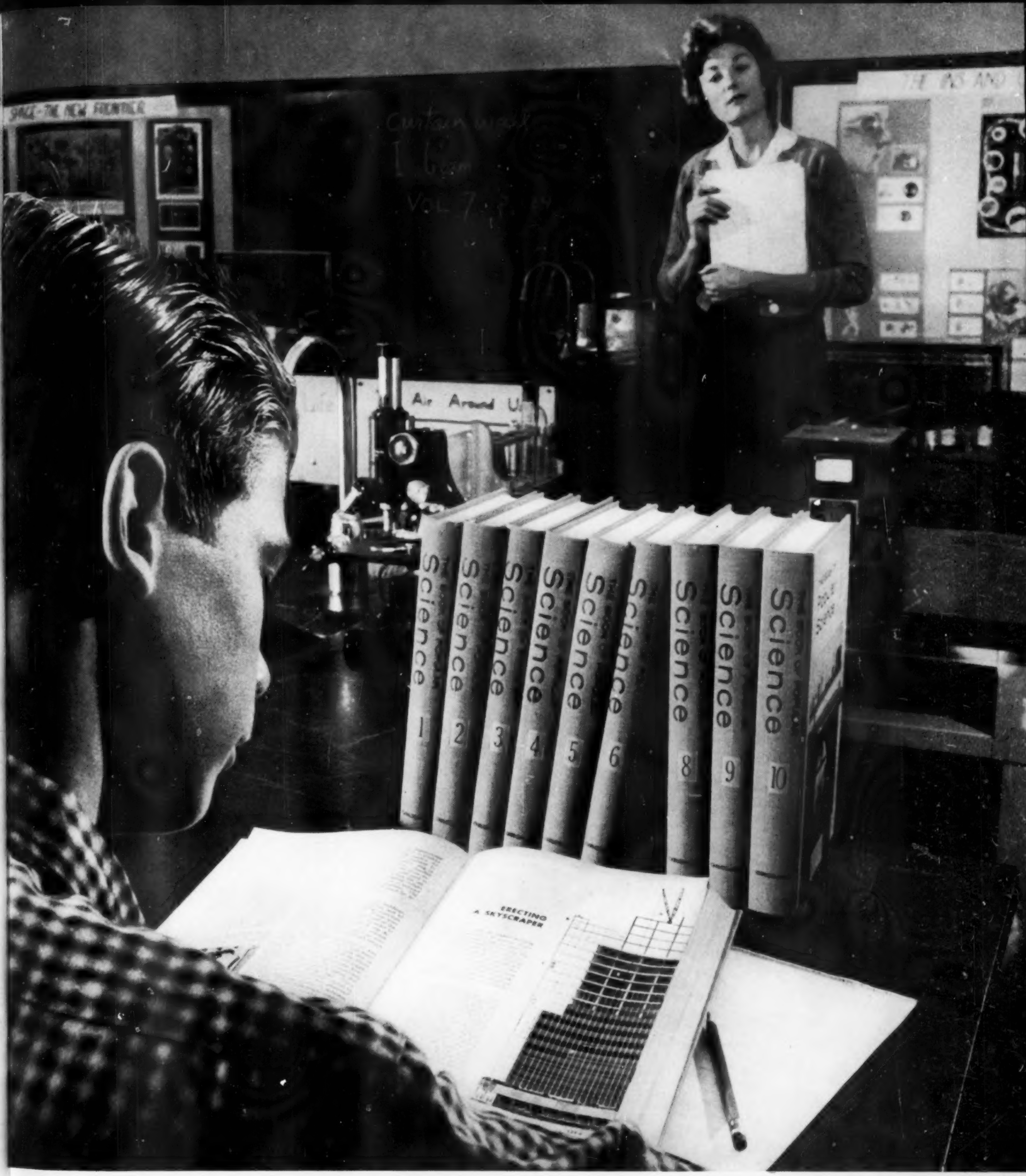
**Visiting Scientists Lectureship Program (SIAM)**

The Society for Industrial and Applied Mathematics announces the continuation of its Visiting Scientists Lectureship Program for the 1960-61 academic year. The program is supported in part by a grant from the National Science Foundation. Organized for the purpose of providing the broadest geographical coverage consistent with available talent throughout the United States, the program is administered by a committee member in six regional areas.

Information about the separate panel rosters established under this program, and names of committee members in the respective geographical areas may be obtained by writing to the Chairman of the SIAM Lectureship Program, Dr. John K. Sterrett, 2321 Jameson St., S. E., Washington 21, D. C.

**EDITOR'S NOTE: The name of the co-author, Erik Bonde of the University of Colorado, Boulder, was inadvertently omitted from the article by Robert W. Stegner, "The Regulation of Plant Growth," (see November *TST*, page 18).**

### Index of Advertisers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Science 8
Science 9
Science 10
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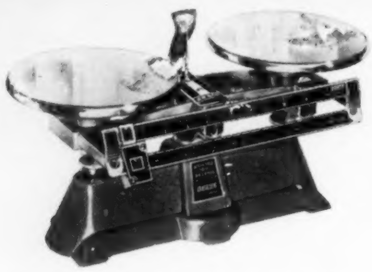

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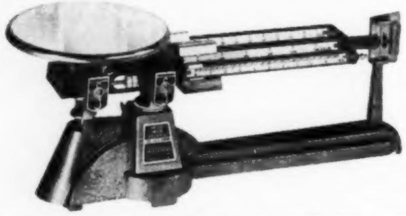

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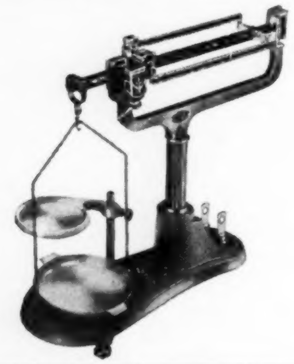

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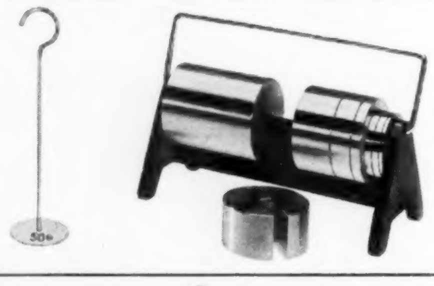

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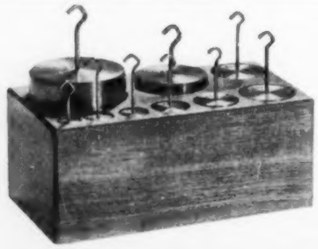

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